SCIENCE

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FRIDAY, MAY 12, 1899.

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MSS. intended or publication and books, etc., intended for review should be sent to the responsible editor, Professor J. McKeen Cattell, Garrison-on-Hudson N. Y.

*THE AGE OF THE EARTH AS AN ABODE FITTED FOR LIFE.**

§ 1. THE age of the earth as an abode fitted for life is certainly a subject which largely interests mankind in general. For geology it is of vital and fundamental importance—as important as the date of the battle of Hastings is for English history—yet it was very little thought of by geologists of thirty or forty years ago; how little is illustrated by a statement,† which I will now read, given originally from the presidential chair of the Geological Society by Professor Huxley in 1869, when for a second time, after a seven years' interval, he was President of the Society:

"I do not suppose that at the present day any geologist would be found * * * to deny that the rapidity of the rotation of the earth *may* be diminishing, that the sun *may* be waxing dim, or that the earth itself *may* be cooling. Most of us, I suspect, are Gallios, 'who care for none of these things,' being of opinion that, true or fictitious, they have made no practical difference to the earth, during the period of which a record is preserved in stratified deposits."

§ 2. I believe the explanation of how it was possible for Professor Huxley to say that he and other geologists did not care for things on which the age of life on the

* The annual address (1897) of the Victoria Institute, by Lord Kelvin, with additions written at different times from June, 1897, to May, 1898. Printed also in the *Philosophical Magazine*.

† In the printed quotations the italics are mine in every case, not so the capitals in the quotation from Page's Text-book.

earth essentially depends, is because he did not know that there was valid foundation for any estimates worth considering as to absolute magnitudes. If science did not allow us to give any estimate whatever as to whether 10,000,000 or 10,000,000,000 years is the age of this earth as an abode fitted for life, then I think Professor Huxley would have been perfectly right in saying that geologists should not trouble themselves about it, and biologists should go on in their own way, not inquiring into things utterly beyond the power of human understanding and scientific investigation. This would have left geology much in the same position as that in which English history would be if it were impossible to ascertain whether the battle of Hastings took place 800 years ago, or 800 thousand years ago, or 800 million years ago. If it were absolutely impossible to find out which of these periods is more probable than the other, then I agree we might be Gallios as to the date of the Norman Conquest. But a change took place just about the time to which I refer, and from then till now geologists have not considered the question of absolute dates in their science as outside the scope of their investigations.

§ 3. I may be allowed to read a few extracts to indicate how geological thought was expressed in respect to this subject, in various largely-used popular text-books, and in scientific writings which were new in 1868, or not so old as to be forgotten. I have several short extracts to read and I hope you will not find them tedious.

The first is three lines from Darwin's 'Origin of Species,' 1859 Edition, p. 287 :

"In all probability a far longer period than 300,000,000 years has elapsed since the latter part of the secondary period."

Here is another still more important sentence, which I read to you from the same book :

"He who can read Sir Charles Lyell's grand work on the Principles of Geology, which the future historian will recognize as having produced a revolution in natural science, yet does not admit how *incomprehensibly vast* have been the past periods of time, *may at once close this volume.*"

I shall next read a short statement from Page's 'Advanced Students' Text-Book of Geology,' published in 1859 :

"Again, where the FORCE seems unequal to the result the student should never lose sight of the element TIME, *an element to which we can set no bounds in the past*, any more than we know of its limit in the future.

"It will be seen from this hasty indication that there are two great schools of geological causation—the one ascribing every result to the ordinary operations of Nature, combined with the element of *unlimited time;* the other appealing to agents that operated during the earlier epochs of the world with greater intensity, and also for the most part over wider areas. *The former belief is certainly more in accordance with the spirit of right philosophy*, though it must be confessed that many problems in geology seem to find their solution only through the admission of the latter hypothesis."

§ 4. I have several other statements which I think you may hear with some interest. Dr. Samuel Haughton, of Trinity College, Dublin, in his 'Manual of Geology,' published in 1865, p. 82, says :

"The infinite time of the geologists is in the past; and *most of their speculations regarding this subject seem to imply the absolute infinity of time*, as if the human imagination was unable to grasp the period of time requisite for the formation of a few inches of sand or feet of mud, and its subsequent consolidation into rock." (This delicate satire is certainly not overstrained.)

"Professor Thomson has made an attempt to calculate the length of time during which the sun can have gone on burning at the present rate, and has come to the following conclusion : "It seems, on the whole, most probable that the sun has not illuminated the earth for 100,000,000 years, and almost certain that he has not done so for 500,000,000 years. As for the future, we may say with equal certainty, that the inhabitants of the earth cannot continue to enjoy the light and heat essential to their life for many million years longer, unless new sources, now

unknown to us, are prepared in the great storehouse of creation."

I said that in the sixties and I repeat it now, but with charming logic it is held to be inconsistent with a later statement that the sun has not been shining 60,000,000 years, and that both that and this are stultified by a still closer estimate which says that probably the sun has not been shining for 30,000,000 years! And so my efforts to find some limit or estimate for Geological Time have been referred to and put before the public, even in London daily and weekly papers, to show how exceedingly wild are the wanderings of physicists, and how mutually contradictory are their conclusions, as to the length of time which has actually passed since the early geographical epochs to the present date.

Dr. Haughton further goes on:

"*This result* (100 to 500 million years) of Professor Thomson's, *although very liberal in the allowance of time, has offended geologists, because, having been accustomed to deal with time as an infinite quantity at their disposal, they feel naturally embarrassment and alarm at any attempt of the science of physics to place a limit upon their speculations.* It is quite possible that even a hundred million of years may be greatly in excess of the actual time during which the sun's heat has remained constant."

§ 5. Dr. Haughton admitted so much with a candid open mind, but he went on to express his own belief (in 1865) thus:

"Although I have spoken somewhat disrespectfully of the geological calculus in my lecture, yet I believe that the time during which organic life has existed on the earth is practically infinite, because it can be shown to be so great as to be inconceivable by beings of our limited intelligence."

Where is inconceivableness in 10,000,000,000? There is nothing inconceivable in the number of persons in this room or in London. We get up to millions quickly. Is there anything inconceivable in 30,000,000 as the population of England, or in 38,000,000 as the population of Great Britain and Ireland, or in 352,704,863 as the population of the British Empire? Not at all. It is just as conceivable as half a million years or 500 millions.

§ 6. The following statement is from Professor Jukes's 'Students' Manual of Geology:'

"The time required for such a slow process to effect such enormous results must, of course, be taken to be inconceivably great. The word 'inconceivably' is not here used in a vague but in a literal sense, to indicate that the lapse of time required for the denudation that has produced the present surfaces of some of the older rocks is vast beyond any idea of time which the human mind is capable of conceiving.

"Mr. Darwin, in his admirably reasoned book on the origin of species, so full of information and suggestion on all geological subjects, estimates the time required for denudation of the rocks of the Weald of Kent, or the erosion of space between the ranges of chalk hills, known as the North and South Downs, at *three hundred millions of years*. The grounds for forming this estimate are, of course, of the vaguest description. It may be possible, perhaps, that the estimate is a hundred times too great, and that the real time elapsed did not exceed three million years, but, on the other hand, it is just as likely that the time which actually elapsed since the first commencement of the erosion till it was nearly as complete as it now is was really a hundred times greater than his estimate, or thirty thousand millions of years."

§ 7. Thus Jukes allowed estimates of anything from 3 millions to 30,000 millions as the time which actually passed during the denudation of the Weald. On the other hand, Professor Phillips, in his Rede lecture to the University of Cambridge (1860), decidedly prefers one inch per annum to Darwin's one inch per century as the rate of erosion, and says that most observers would consider even the one inch per annum too small for all but the most invincible coasts! He thus, on purely geological grounds, reduces Darwin's estimate of the time to less than one one-hundredth. And, reckoning the actual thicknesses of all the known geological strata of the earth, he finds 96 million years as a possible estimate for the antiquity of the base of the stratified rocks; but he gives reasons for supposing that this may be an overestimate, and he

finds that from stratigraphical evidence alone we may regard the antiquity of life on the earth as possibly between 38 millions and 96 millions of years. Quite lately a very careful estimate of the antiquity of strata containing remains of life on the earth has been given by Professor Sollas, of Oxford, calculated according to stratigraphical principles which had been pointed out by Mr. Alfred Wallace. Here it is*: "So far as I can at present see, the lapse of time since the beginning of the Cambrian system is probably less than 17,000,000 years, even when computed on an assumption of uniformity, which to me seems contradicted by the most salient facts of geology. Whatever additional time the calculations made on physical data can afford us may go to the account of pre-Cambrian deposits, of which at present we know too little to serve for an independent estimate."

§ 8. In one of the evening Conversaziones of the British Association during its meeting at Dundee in 1867 I had a conversation on geological time with the late Sir Andrew Ramsay, almost every word of which remains stamped on my mind to this day. We had been hearing a brilliant and suggestive lecture by Professor (now Sir Archibald) Geikie on the geological history of the actions by which the existing scenery of Scotland was produced. I asked Ramsay how long a time he allowed for that history. He answered that he could suggest no limit to it. I said, "You don't suppose things have been going on always as they are now? You don't suppose geological history has run through 1,000,000,000 years?" "Certainly I do." "10,000,000,000 years?" "Yes." "The sun is a finite body. You can tell how many tons it is. Do you think it has been shining on for a million million years?" "I am as incapable of estimating and understanding the reasons which you physicists have for limiting geological time as you are incapable of understanding the geological reasons for our unlimited estimates." I answered, "You can understand physicists' reasoning perfectly if you give your mind to it." I ventured also to say that physicists were not wholly incapable of appreciating geological difficulties; and so the matter ended, and we had a friendly agreement to temporarily differ.

§ 9. In fact, from about the beginning of the century till that time (1867), geologists had been nurtured in a philosophy originating with the Huttonian system: much of it substantially very good philosophy, but some of it essentially unsound and misleading; witness this, from Playfair, the eloquent and able expounder of Hutton:

"How often these vicissitudes of decay and renovation have been repeated is not for us to determine; they constitute a series of which as the author of this theory has remarked, we neither see the beginning nor the end; a circumstance that accords well with what is known concerning other parts of the economy of the world. In the continuation of the different species of animals and vegetables that inhabit the earth, we discern neither a beginning nor an end; in the planetary motions where geometry has carried the eye so far both into the future and the past we discover no mark either of the commencement or the termination of the present order."

§ 10. Led by Hutton and Playfair, Lyell taught the doctrine of eternity and uniformity in geology; and to explain plutonic action and underground heat, invented a thermo-electric 'perpetual' motion on which, in the year 1862, in my paper on the 'Secular Cooling of the Earth,'* published in the 'Transactions of the Royal Society of Edinburgh,' I commented as follows:

"To suppose, as Lyell, adopting the chemical hypothesis, has done,† that the substances, combining together, may be again separated electrolytically by thermo-electric currents, due to the heat generated by their combination, and thus the chemical action and

*'The Age of the Earth,' *Nature*, April 4, 1895.

* Reprinted in Thomson and Tait 'Treatise on Natural Philosophy,' 1st and 2d Editions, Appendix D (g).

† 'Principles of Geology,' Chap. XXXI., ed. 1853.

its heat continued in an endless cycle, violates the principles of natural philosophy in exactly the same manner, and to the same degree, as to believe that a clock constructed with a self-winding movement may fulfil the expectations of its ingenious inventor by going forever."

It was only by sheer force of reason that geologists have been compelled to think otherwise, and to see that there was a definite beginning, and to look forward to a definite end of this world as an abode fitted for life.

§ 11. It is curious that English philosophers and writers should not have noticed how Newton treated the astronomical problem. Playfair, in what I have read to you, speaks of the planetary system as being absolutely eternal, and unchangeable; having had no beginning and showing no signs of progress towards an end. He assumes also that the sun is to go on shining forever and that the earth is to go on revolving round it forever. He quite overlooked Laplace's nebular theory; and he overlooked Newton's counterblast to the planetary 'perpetual motion.' Newton, commenting on his own 'First Law of Motion,' says, in his terse Latin, which I will endeavor to translate, "But the greater bodies of planets and comets moving in spaces less resisting keep their motions longer." That is a strong counterblast against any idea of eternity in the planetary system.

§ 12. I shall now, without further preface, explain, and I hope briefly, so as not to wear out your patience, some of the arguments that I brought forward between 1862 and 1869, to show strict limitations to the possible age of the earth as an abode fitted for life.

Kant* pointed out in the middle of last century what had not previously been discovered by mathematicians or physical astronomers, that the frictional resistance against tidal currents on the earth's surface must cause a diminution of the earth's rotational speed. This really great discovery in natural philosophy seems to have attracted very little attention—indeed to have passed quite unnoticed—among mathematicians and astronomers and naturalists, until about 1840, when the doctrine of energy began to be taken to heart. In 1866, Delaunay suggested that tidal retardation of the earth's rotation was probably the cause of an outstanding acceleration of the moon's mean motion reckoned according to the earth's rotation as a timekeeper found by Adams in 1853 by correcting a calculation of Laplace which had seemed to prove the earth's rotational speed to be uniform.* Adopting Delaunay's suggestion as true, Adams, in conjunction with Professor Tait and myself, estimated the diminution of the earth's rotational speed to be such that the earth as a timekeeper, in the course of a century, would get 22 seconds behind a thoroughly perfect watch or clock rated to agree with it at the beginning of the century. According to this rate of retardation the earth, 7,200 million years ago, would have been rotating twice as fast as now; and the centrifugal force in the equatorial regions would have

* In an essay first published in the Königsberg *Nachrichten*, 1754, Nos. 23, 24; having been written with reference to the offer of a prize by the Berlin Academy of Sciences in 1754. Here is the title page in full as it appears in Vol. VI. of Kant's Collected Works, Leipzig, 1839: Untersuchung der Frage: Ob die Erde in ihrer Umdrehung um die Achse, wodurch sie die Abwechselung des Tages und der Nacht hervorbringt, einige Veränderung seit den ersten Zeiten ihres Urspunges erlitten habe, welches die Ursache davon sei, und woraus man sich ihrer versichern könne? welche von der Königlichen Akademie der Wissenschaften zu Berlin zum Preise aufgegeben worden, 1754.

* 'Treatise on Natural Philosophy' (Thomson and Tait), § 830, ed. 1, 1867, and later editions; also 'Popular Lectures and Addresses,' Vol. II. (Kelvin), 'Geological Time,' being a reprint of an article communicated to the Glasgow Geological Society, February 27, 1868.

been four times as great as its present amount, which is $\frac{1}{289}$ of gravity. At present the radius of the equatorial sea-level exceeds the polar semi-diameter by $21\frac{1}{2}$ kilometers, which is, as nearly as the most careful calculations in the theory of the earth's figure can tell us, just what the excess of equatorial radius of the surface of the sea all round would be if the whole material of the earth were at present liquid and in equilibrium under the influence of gravity and centrifugal force with the present rotational speed, and $\frac{1}{4}$ of what it would be if the rotational speed were twice as great. Hence, if the rotational speed had been twice as great as its present amount when consolidation from approximately the figure of fluid equilibrium took place, and if the solid earth, remaining absolutely rigid, had been gradually slowed down in the course of millions of years to its present speed of rotation, the water would have settled into two circular oceans round the two poles; and the equator, dry all round, would be 64.5 kilometers above the level of the polar sea bottoms. This is on the supposition of absolute rigidity of the earth after primitive consolidation. There would, in reality, have been some degree of yielding to the gravitational tendency to level the great gentle slope up from each pole to equator. But if the earth, at the time of primitive consolidation, had been rotating twice as fast as at present, or even 20 per cent. faster than at present, traces of its present figure must have been left in a great preponderance of land, and probably no sea at all, in the equatorial regions. Taking into account all uncertainties, whether in respect to Adams' estimate of the rate of frictional retardation of the earth's rotatory speed, or to the conditions as to the rigidity of the earth once consolidated, we may safely conclude that the earth was certainly not solid 5,000 million years ago, and was probably not solid 1,000 million years ago.*

§ 13. A second argument for limitation of the earth's age, which was really my own first argument, is founded on the consideration of underground heat. To explain a first rough and ready estimate of it I shall read one short statement. It is from a very short paper that I communicated to the Royal Society of Edinburgh on the 18th December, 1865, entitled, 'The Doctrine of Uniformity in Geology Briefly Refuted:'

"The 'Doctrine of Uniformity' in Geology, as held by many of the most eminent of British Geologists, assumes that the earth's surface and upper crust have been nearly as they are at present in temperature, and other physical qualities, during millions of millions of years. But *the heat which we know, by observation, to be now conducted out of the earth yearly* is so great, that if this action had been going on with any approach to uniformity for 20,000 million years, the amount of heat lost out of the earth would have been about as much as would heat, by 100° C., a quantity of ordinary surface rock of 100 times the earth's bulk. This would be more than enough to melt a mass of surface rock equal in bulk to the whole earth. No hypothesis as to chemical action, internal fluidity, effects of pressure at great depth, or possible character of substances in the interior of the earth, possessing the smallest vestige of probability, can justify the supposition that the earth's upper crust has remained nearly as it is, while from the whole, or from any part, of the earth, so great a quantity of heat has been lost."

§ 14. The sixteen words which I have emphasized in reading this statement to you (italics in the reprint) indicate the matter-of-fact foundation for the conclusion asserted. This conclusion suffices to sweep away the whole system of geological and biological speculation demanding an 'in-

* The fact that the continents are arranged along meridians rather than in an equatorial belt affords some degree of proof that the consolidation of the earth took place at a time when the diurnal rotation differed but little from its present value. It is probable that the date of consolidation is considerably more recent than a thousand million years ago."—Thomson and Tait, 'Treatise on Natural Philosophy,' 2d ed., 1883, § 830.

conceivably' great vista of past time, or even a few thousand million years, for the history of life on the earth, and approximate uniformity of plutonic action throughout that time; which, as we have seen, was very generally prevalent thirty years ago, among British Geologists and Biologists; and which, I must say, some of our chiefs of the present day have not yet abandoned. Witness the Presidents of the Geological and Zoological Sections of the British Association at its meetings of 1893 (Nottingham), and of 1896 (Liverpool):

Mr. Teall: Presidential Address to the Geological Section, 1893, "The good old British ship 'Uniformity,' built by Hutton and refitted by Lyell, has won so many glorious victories in the past, and appears still to be in such excellent fighting trim, that I see no reason why she should haul down her colors either to 'Catastrophe' or 'Evolution.' Instead, therefore, of acceding to the request to 'hurry up' we make a demand for more time."

Professor Poulton: Presidential Address to the Zoological Section, 1896. "Our argument does not deal with the time required for the origin of life, or for the development of the lowest beings with which we are acquainted from the first formed beings, of which we know nothing. Both these processes may have required an immensity of time; but as we know nothing whatever about them and have as yet no prospect of acquiring any information, we are compelled to confine ourselves to as much of the process of evolution as we can infer from the structure of living and fossil forms—that is, as regards animals, to the development of the simplest into the most complex Protozoa, the evolution of the Metazoa from the Protozoa, and the branching of the former into its numerous Phyla, with all their Classes, Orders, Families, Genera, and Species. But we shall find that this is quite enough to necessitate *a very large increase in the time estimated by the geologist.*"

§ 15. In my own short paper from which I have read you a sentence, the rate at which heat is at the present time lost from the earth by conduction outwards through the upper crust, as proved by observations of underground temperature in different parts of the world, and by measurement of the thermal conductivity of surface rocks and strata, sufficed to utterly refute the Doctrine of Uniformity as taught by Hutton, Lyell, and their followers; which was the sole object of that paper.

§ 16. In an earlier communication to the Royal Society of Edinburgh,* I had considered the cooling of the earth due to this loss of heat; and by tracing backwards the process of cooling had formed a definite estimate of the greatest and least number of million years which can possibly have passed since the surface of the earth was everywhere red hot. I expressed my conclusion in the following statement: †

"We are very ignorant as to the effects of high temperatures in altering the conductivities and specific heats and melting temperatures of rocks, and as to their latent heat of fusion. We must, therefore, allow very wide limits in such an estimate as I have attempted to make; but I think we may with much probability say that the consolidation cannot have taken place less than 20 million years ago, or we should now have more underground heat than we actually have; nor more than 400 million years ago, or we should now have less underground heat than we actually have. That is to say, I conclude that Leibnitz's epoch of emergence of the *consistentior status* [the consolidation of the earth from red hot or white hot molten matter] was probably between those dates."

§ 17. During the 35 years which have passed since I gave this wide-ranged estimate, experimental investigation has supplied much of the knowledge then wanting regarding the thermal properties of rocks to form a closer estimate of the time which has passed since the consolidation of the earth, and we have now good reason for judging that it was more than 20 and less than 40 million years ago; and probably much nearer 20 than 40.

§ 18. Twelve years ago, in a laboratory established by Mr. Clarence King, in con-

* 'On the Secular Cooling of the Earth,' Trans. Roy. Soc. Edinburgh, Vol. XXIII., April 28, 1862, reprinted in Thomson and Tait, Vol. III., pp. 468–485, and Math. and Phys. Papers, art. XCIV., pp. 295–311.

† 'On the Secular Cooling of the Earth,' Math. and Phys. Papers, Vol. III., § 11 of art. XCIV.

nection with the United States Geological Survey, a very important series of experimental researches on the physical properties of rocks at high temperatures was commenced by Dr. Carl Barus, for the purpose of supplying trustworthy data for geological theory. Mr. Clarence King, in an article published in the *American Journal of Science*,* used data thus supplied, to estimate the age of the earth more definitely than was possible for me to do in 1862, with the very meagre information then available as to the specific heats, thermal conductivities, and temperatures of fusion of rocks. I had taken 7000° F. (3781° C.) as a high estimate of the temperature of melting rock. Even then I might have taken something between 1000° C. and 2000° C. as more probable, but I was most anxious not to *underestimate* the age of the earth, and so I founded my primary calculation on the 7000° F. for the temperature of melting rock. We know now from the experiments of Carl Barus† that diabase, a typical basalt of very primitive character, melts between 1100° C. and 1170°, and is thoroughly liquid at 1200°. The correction from 3871° C. to 1200° or 1/3.22 of that value, for the temperature of solidification, would, with no other change of assumptions, reduce my estimate of 100 millions to $1/(3.22)^2$ of its amount, or a little less than 10 million years; but the effect of pressure on the temperature of solidification must also be taken into account, and Mr. Clarence King, after a careful scrutiny of all the data given him for this purpose by Dr. Barus, concludes that without further experimental data 'we have no warrant for extending the earth's age beyond 24 millions of years.'

§ 19. By an elaborate piece of mathematical bookkeeping, I have worked out the problem of the conduction of heat outwards from the earth, with specific heat increasing up to the melting point as found by Rücker and Roberts-Austen and by Barus, but with the conductivity assumed constant; and, by taking into account the augmentation of melting temperature with pressure in a somewhat more complete manner than that adopted by Mr. Clarence King, I am not led to differ much from his estimate of 24 million years. But, until we know something more than we know at present as to the probable diminution of thermal conductivity with increasing temperature, which would shorten the time since consolidation, it would be quite inadvisable to publish any closer estimate.

§ 20. All these reckonings of the history of underground heat, the details of which I am sure you do not wish me to put before you at present, are founded on the very sure assumption that the material of our present solid earth all round its surface was at one time a white-hot liquid. The earth is at present losing heat from its surface all round from year to year and century to century. We may dismiss as utterly untenable any supposition such as that a few thousand or a few million years of the present régime in this respect was preceded by a few thousand or a few million years of heating from without. History, guided by science, is bound to find, if possible, an antecedent condition preceding every known state of affairs, whether of dead matter or of living creatures. Unless the earth was created solid and hot out of nothing, the régime of continued loss of heat must have been preceded by molten matter all round the surface.

§ 21. I have given strong reasons* for believing that *immediately* before solidification at the surface, the interior was solid

* 'On the Age of the Earth,' Vol. XLV., January, 1893.

† *Phil. Mag.* 1893, first half-year, pp. 186, 187, 301–305.

* On the Secular Cooling of the Earth, Vol. III. Math. and Phys. Papers, §§ 19–33.

close up to the surface; except comparatively small portions of lava or melted rock among the solid masses of denser solid rock which had sunk through the liquid, and possibly a somewhat larger space around the center occupied by platinum, gold, silver, lead, copper, iron and other dense metals, still remaining liquid under very high pressure.

§ 22. I wish now to speak to you of depths below the great surface of liquid lava bounding the earth before consolidation; and of mountain heights and ocean depths formed probably a few years after a first emergence of solid rock from the liquid surface (see § 24, below) which must have been quickly followed by a complete consolidation all around the globe. But I must first ask you to excuse my giving you all my depths, heights and distances, in terms of the kilometer, being about six-tenths of that very inconvenient measure the English statute mile, which, with all the other monstrosities of our British metrical system, will, let us hope, not long survive the legislation of our present Parliamentary session destined to honor the sixty years' Jubilee of Queen Victoria's reign by legalizing, the French metrical system for the United Kingdom.

§ 23. To prepare for considering consolidation at the surface let us go back to a time (probably not more than twenty years earlier as we shall presently see—§ 24) when the solid nucleus was covered with liquid lava to a depth of several kilometers; to fix our ideas let us say 40 kilometers (or 4 million centimeters). At this depth in lava, if of specific gravity 2.5, the hydrostatic pressure is 10 tons weight (10 million grammes) per square centimeter, or ten thousand atmospheres approximately. According to the laboratory experiments of Clarence King and Carl Barus* on Diabase, and the thermodynamic theory* of my brother, the late Professor James Thomson, the melting temperature of diabase is 1170° C. at ordinary atmospheric pressure, and would be 1420° under the pressure of ten thousand atmospheres, if the rise of temperature with pressure followed the law of simple proportion up to so high a pressure.

§ 24. The temperature of our 40 kilometers deep lava ocean of melted diabase may therefore be taken as but little less than 1420° from surface to bottom. Its surface would radiate heat out into space at some such rate as two (gramme-water) thermal units Centigrade per square centimeter per second.† Thus, in a year ($31\frac{1}{2}$ million seconds) 63 million thermal units would be lost per square centimeter from the surface. This is, according to Carl Barus, very nearly equal to the latent heat of fusion abandoned by a million cubic centimeters of melted diabase in solidfying into the glassy condition (pitch-stone) which is assumed when the freezing takes place in the course of a few minutes. But, as found by Sir James Hall in his Edinburgh experiments‡ of 100 years ago, when more than a few minutes is taken for the freezing, the solid formed is not a glass but a heterogeneous crystalline solid of rough fracture; and if a few hours or days, or any longer time, is taken, the solid formed has the well-known rough crystalline structure of basaltic rocks found in all parts of the world. Now Carl Barus finds that basaltic

* *Philosophical Magazine*, 1893, first half-year, p. 306.

* Trans. Roy. Soc., Edinburgh, Jan. 2, 1849; Cambridge and Dublin *Mathematical Journal*, Nov., 1850. Reprinted in Math. and Phys. Papers (Kelvin), Vol. I., p. 156.

† This is a very rough estimate which I have formed from consideration of J. T. Bottomley's accurate determinations in absolute measure of thermal radiation at temperatures up to 920° C. from platinum wire and from polished and blackened surfaces of various kinds in receivers of air-pumps exhausted down to one ten-millionth of the atmospheric pressure. Phil. Trans. Roy. Soc., 1887 and 1893.

‡ Trans. Roy. Soc. Edinburgh.

diabase is 14 per cent. denser than melted diabase, and 10 per cent. denser than the glass produced by quick freezing of the liquid. He gives no data, nor do Rücker and Roberts-Austen, who have also experimented on the thermodynamic properties of melted basalt, give any data, as to the latent heat evolved in the consolidation of liquid lava into rock of basaltic quality. Guessing it as three times the latent heat of fusion of the diabase pitch-stone, I estimate a million cubic centimeters of liquid frozen per square centimeter per centimeter per three years. This would diminish the depth of the liquid at the rate of a million centimeters per three years, or 40 kilometers in twelve years.

§ 25. Let us now consider in what manner this diminution of depth of the lava ocean must have proceeded, by the freezing of portions of it; all having been at temperatures very little below the assumed 1420° melting temperature of the bottom, when the depth was 40 kilometers. The loss of heat from the white-hot surface (temperatures from 1420° to perhaps 1380° in different parts) at our assumed rate of two (gramme-water Centigrade) thermal units per sq. cm. per sec. produces very rapid cooling of the liquid within a few centimeters of the surface (thermal capacity .36 per gramme, according to Barus) and in consequence great downward rushes of this cooled liquid, and upwards of hot liquid, spreading out horizontally in all directions when it reaches the surface. When the sinking liquid gets within perhaps 20 or 10 or 5 kilometers of the bottom, its temperature* becomes the freezing-point as raised by the increased pressure; or, perhaps more correctly stated, a temperature at which some of its ingredients crystallized out of it. Hence, beginning a few kilometers above the bottom, we have a snow shower of solidified lava or of crystalline flakes, or prisms, or granules of feldspar, mica, hornblende, quartz, and other ingredients: each little crystal gaining mass and falling somewhat faster than the descending liquid around it till it reaches the bottom. This process goes on until, by the heaping of granules and crystals on the bottom, our lava ocean becomes silted up to the surface.

(*To be concluded.*)

* The temperature of the sinking liquid rock rises in virtue of the increasing pressure: but much less then does the freezing point of the liquid or of some of its ingredients. (See Kelvin, Math. and Phys. Papers, Vol. III., pp. 69, 70.)

THE POSTHOM PHANTOM: A STUDY IN THE SPONTANEOUS ACTIVITY OF SHADOWS.*

At the April meeting of the Astral Camera Club of Alcalde the veteran sciosophist and former President of the Stanislaus Geological Society, Mr. Abner Dean of Angels, described his investigations of shadow-life, as exemplified in the strange case of Peter Schlemihl.

It seems that this gentleman, late a resident of Kunersdorf, in Germany, on one occasion was approached by a gray-haired stranger who offered to purchase his shadow. Schlemihl named a price, which was instantly accepted. Thereupon the stranger knelt upon the grass, rolled up the shadow, folded it neatly and thrust it into his knapsack, at once disappearing down the road between two hedges of roses, leaving Schlemihl himself absolutely shadowless.

At first the poor man took the deprivation lightly. But, as time went on, the singularity of his position wore upon him, the whispered words and doubtful glances of his friends began to distress him, and he fell into a condition of marked physical discomfort. He set out in search of

* 'Posthumous Humanity:' A study of Phantoms, by Adolph D'Assier, Member of the Bordeaux Academy of Sciences. Translated and Annotated by Henry S. Olcott; London, George Redway, York St., Covent Garden.

the shadow and, after many adventures, he overtook the man to whom he had sold it. But neither promises nor blows availed anything. The stranger turned a deaf ear to the former, and the latter only served to tear or bruise the shadow which the stranger used in self-defence. When at last Schlemihl died it was observed he left no wraith to rustle through the old graveyard at Kunersdorf. According to Mr. Chamisso, a friend of Schlemihl, who has recorded the facts above noted, "An event had taken the place of an action as has happened not infrequently in the world's history." That he was unable to nullify this event was supposed to be the cause of the failure of his efforts at self-realization. But this ethereal epigram does not explain why the loss of his shadow made him physically uncomfortable. For the cause of this we must search in the fluidic conditions by which he was surrounded.

Mr. Dean has, therefore, devoted special attention to these details, to make clear the nature of the shadow itself and of the being who made way with it.

Certain writers have too hastily assumed that this being was the Devil. This is obviously not the case, for this fabled creation, the 'Faded fancy of an elder world,' 'the fluidic phantom of effete orthodoxy,' as Mr. Dean styled it, has no objective existence. The fact that the stranger was dressed in black which seemed red by transmitted light, and that he exhaled a faint sulphurous aroma, would seem to bear out this supposition. But these details were more likely results of pure fancy, perhaps heightened by the presence of a highly concentrated fluidic aura.

The real nature of the being is shown by the erudite researches of Dr. Adolph D'Assier on the 'fauna of the shades,' as set forth in his remarkable volume on 'Posthumous Humanity.' The stranger was, doubtless, a lycanthropic posthom, or shadow-devouring phantom, who, being unable to suck the blood of Schlemihl himself, carried away his shadow to strengthen his own fast waning identity. There are many records, especially among the peasants of Little Russia, of phantoms who satisfy their hunger in this uncanny way. The word lycanthropic (wolf-manly) was drawn from this common habit with the wehr-wolf, the phantasmal double of the common gray wolf. The same tendencies are found in posthoms of wolf-like men to which the generic term 'lycanthropic' is also applied. It may be noted that now the wolf is practically extinct in the forests of Germany; its posthom, the wehr-wolf, no longer appears and its familiar call of 'willi-wa-wu: wito-hu' is no longer heard in the German shades.

The name posthom (*post*—after; *homo*—man) was some years since offered by Mr. Dean as a general designation for those phantasmal doubles which D'Assier calls by the awkward and inadequate name of fluidic forms or fluidic phantoms. It was at first supposed that these creations were exclusively human and natural sequences of physical death. The error of this opinion is now made evident, but the convenient name, as more definite than phantom and more generic than wraith, may still be retained with this broader definition.

The origin of the posthom is thus explained by Mr. Dean: It is well known that all animals and plants are built up of cells or chambers, each cell containing the magnetic life jelly or protoplasm. It is also well established that these cells are not completely filled by this substance. Moreover, it is known that even protoplasm itself is not a true liquid, but a mass of network, like a skein of tangled yarn. In this cell and its skein of protoplasm the minute atoms of the odic forces of the universe penetrate. In so doing, by their entanglement and permeation, they built up within the cells a form corresponding in all re-

spects to that of the living creature as a whole, but in reality its double or negative, being solid only when the first is empty, and being empty when the first is solid.

The well-known astral body of man is a species of posthom. But astrality is not confined to man. It has been shown by Mr. William Q. Judge that the 'body of the jelly-fish is almost pure astral substance.' It is, in fact, a posthom of a marine organism which has become saturated with water, which fills all the interstices in its anatomy, thus giving it an independent and self-perpetuating existence. For the distinguished scientist of the Society of Bordeaux has shown that the posthom phantom of man is "the exact image of the person of whom it is the complement. Internally it represents the mould of all the organs which constitute the framework of the human body. We see it, in short, move, speak, take nourishment, perform, in a word, all the great functions of animal life. The extreme tenuity of these constituent molecules, which represent the last term of organic matter, allow it to pass through the walls and partitions of apartments. Nevertheless, as it is united with the body, from which it emanates by an invisible vascular plexus, it can, at will, draw to itself, by a sort of aspiration, the greater part of the living forces which animate the latter. One sees, then, by a singular inversion, life withdrawn from the body, which then exhibits a cadaverous rigidity and transfers itself entirely to the phantom, which acquires consistency, sometimes even to the point of struggling with persons before whom it materializes. It is but exceptionally that it shows itself in connection with a living person." But as soon as death has snapped the bonds (or vascular plexus) that attach it to our organism it definitely separates itself from the human body and constitutes the 'posthumous phantom' or posthom.

The fact of the occasional separation of the posthom during life is now perfectly authenticated. The case of Schlemihl comes under this head, as also the remarkable experience related by Mr. H. C. Andersen, of Copenhagen. A Danish country gentleman, of good family, it is alleged, lost his shadow at one time. He took a humorous view of the accident at first and consoled himself with the reflection that the world set too much store on shadows anyhow. But as time went on his philosophy failed. He noted that his own strength oozed away, and later that his clothing was becoming brittle and unable to support the slightest strain. It, too, had lost its shadow. His friends brought him word of strange pranks which his double performed in the society of the neighborhood, although at the same time he was confined to his room and finally to his bed. Apparently the posthom phantom felt a strange delight in bringing its master into ridicule. Finally it boldly usurped his place in social functions, ruling with a high hand and giving him an opportunity to be heard in his own defense. At last, in violent indignation, by a supreme effort of the will, the gentleman recalled the phantom, to the endless mystification of his friends. With the return of the posthom to his own cellular substance his physical and mental vigor returned and his new suit of clothes showed no lack of the ordinary shadow.

It will be noticed that in this case the phantom man was clothed in phantom clothing. This was similarly formed, being made up of the tenuous molecules which filled the cloth cells of the original garments. As it is notorious that posthoms are clothed in materials similar to those worn by the person from whom they are derived, this deserves a moment's explanation.

Dr. D'Assier has conclusively shown that even inanimate bodies have their doubles, or posthoms, as well as men and beasts.

This was at first doubted by that most critical of scientists, Mr. Henry S. Olcott, of Madras. He was, however, convinced of its correctnesss by the well-authenticated fact that inanimate bodies, as rocks and teacups, equally with animate bodies, are able to cast shadows. From the shadows of teacups philosophical generalizations of great value have been obtained in India and Thibet. The only body known to man which has no fluidic double, or shadow, is the sun. Its phantom is, perhaps, the whole visible universe, and it is the undoubted center of that fluidic force which is expulsory of all shadows. The shadow of an object is not as most people suppose, merely the absence of sunshine. If that were all it would be much less substantial in its nature than is now the case and would have no definite boundaries. The shadow is the phantasmal double. All material bodies have interspaces among their atoms corresponding to the cells in living organisms. Indeed, it is well known that molecules of matter nowhere touch one another, nor do they come anywhere near touching. If we could conceive the physical molecules of a rock as inhabited worlds a being with a telescope on one of them would gaze at his neighbor atom as our astronomers gaze forth on the mighty sun of Sirius. It is also well known that molecules do not really exist at all, but that each is really an eddy or storm center, and thus a center of attraction in the fluidic atmosphere of astral substances, in which all inhabited worlds are bathed. But omitting these considerations, which belong to ultimate science, or sciosophy, there is no doubt that the shadow of a man or a rock is itself an objective reality. It is a posthom driven out from its original station by the expellatory force of the sun. "The huge conical shadow of the earth which reaches beyond the moon and is called night" is not merely the absence of light. It is the hour of posthom phantoms when all nature is saturated in fluidic forces. It is natural, then, that at night phantasms of all degrees should be at large, and that in this period and under its conditions all successful studies in the natural history of the shades have been accomplished.

During life the carnate body exerts a strong attraction for its posthom, so that the shadow is seldom seen far away from its host. Toward evening, however, it wanders more widely, and at last it may be apparently wholly detached. Whether this is really ever the case under normal conditions is not yet certainly known. This question will be the subject of further investigations by the members of the club at Alcalde.

Mr. James M. Barrie, of Edinburgh, in a volume bearing the curious title of 'Sentimental Tommy,' tells us that once in his youth he turned a corner in running so suddenly that he thereby 'dislocated his shadow.' It is easy to see that this might occur, though probably infrequently.

It is certain that at death the host ceases to exert any particular hold over its phantasm. The shadow wanders freely and at will. It is soon disconcerted because the stars begin to devour its substance, and it is but rarely that means can be found to resist their malign influence. For this reason all phantoms of the dead are disintegrated and reduced to primæval vapor within a space of ten to twenty days after their disassociation. This fear of dissolution is the cause of the violent excitement often shown by phantoms. From the same cause arises their proneness to linger about the haunts of the host in life or about his place of burial.

Certain classes of posthom phantoms have been known to suck the blood of the living, and thus to maintain a precarious existence for a number of days or weeks. These are known as vampires, and their existence

may usually be recognized by the roseate appearance of the body from which they are derived. It is said that the reduction of this body to ashes by fire will destroy the vampire posthom. At least Mr. Dean is convinced, from the experiences of several peasants in Lithuania, that this is correct. In all events, it is reasonable to suppose that the heat of a funeral pyre would attract the disintegrating posthom, and, once drawn into the current of hot air, it could in no way save itself.

"The most common yearning of the posthumous being," says Dr. D'Assier, "is to bid the last farewell to those who are used to it." But experiments prove that it is equally accessible to ideas of vengeance, while the wraiths of those who are unhappy in their affections are somewhat extremely perverse and demonstrative, being 'not always satisfied to signify resentment by noisy but harmless manifestations.'

While a vast array of cases are cited in support of the theory that posthoms delight in sympathy and in vengeance, one must be very cautious in receiving such evidence. We must not read our own emotions into the vagrant actions of the poor disconsolate shadows. The impending dissolution of posthom stares it, as it were, every moment in the face, and it may follow friend or enemy in the sole hope of somehow drawing substance, either blood or shadow, in order to continue its existence. They cannot last long at the best, nor is it right that they should do so, for if their status were indefinitely prolonged, as some have maintained, the world would long ago have become solidly full of phantoms, and for the amount of fluidic ether necessary for their production we should be obliged to draw on some other universe.

Dr. D'Assier very wisely observes (p. 176, Posthumous Humanity): "The perennial survival of shades would long ago have rendered this planet uninhabitable to us. The dead would occupy the place of the living, for the accumulation of spectres of the different tribes of the terrestrial fauna heaped at the surface of the globe since the first geological epochs would render the air irrespirable. We could not move, save in a dense atmosphere of ghosts. Now, chemical analysis has never shown in the air the presence of either of the immediate principles which enter into the constitution of a fluidic phantasmal form elaborated in an animal economy. For our part we bitterly regret that these venerable shades have disappeared."

The evidence, on the other hand, is, however, worth consideration, as is shown by the following experiments of the famous Allan Kardec. One day his fancy led him to evoke the posthom of Tartuffe.

"Tartuffe did not wait to be dragged out by the ears, but speedily showed himself in all his classical peculiarities! It was veritably the personage created by Molière, with his soft and hypocritical speech, his wheedling ways, his air of sugar-coated piety. When, after close examination, he was satisfied as to the phantom's identity he was transported with pleasure and said to it:

"'By the way, how is it that you are here, seeing that you never had any real existence?'

"'That is true,' answered the spectre in a most contrite tone, 'I am the spirit of an actor who used to play the part of Tartuffe.' Tartuffe, being unable to show himself for a very good reason, sends an actor in his place."

Kardec again tells of a nest of little birds in a garden. The nest having disappeared, the gentleman became uneasy as to the fate of his little pets. Being a person of enormous animal magnetism and, therefore, an adept in the calling and training of posthoms he went through the usual ceremony of calling the phantom of the mother bird, who was seeking caterpillars in a neighboring

tree. The shadow of the bird immediately came to him and replied to the anxious questioner: "Be quite easy. My young ones are safe and sound. The house-cat knocked down the nest in jumping on the garden wall. You will find them in the grass at the foot of the wall." The gentleman hurried to the garden and found the little nestlings full of life at the spot indicated.

As both these stories are pefectly authenticated, we must consider them in the light of our phantom knowledge. As the birds themselves were living at the time, the projection of their shadow offers nothing incongruous, especially if it took place in the dusk of the evening, a detail which Mr. Kardec omits, but which we may readily supply. The natural anxiety of the mother bird would, as it were, lend the shadow wings, and her intensity of feeling would produce the effect of conversation. It is not likely that the bird actually spoke, for the incident took place in France, and no bird, not even the most refined parrot, has yet spoken French. There are other ways of conveying information than word of mouth, and an enlightened master knows how to make use of them. In the case of Tartuffe the phantom may have been real and virtually immortal. It belongs to another class than the shadow phantoms. The creation of a great poet's brain has an objective existence which may be far more permanent than the shadow of an ordinary actor. No doubt, the image formed in the brain having the gigantic aura of that of Molière could so embody itself in astral precipitates as to secure a life which might endure for centuries.

It need surprise no one to meet the phantasm of Tartuffe in real existence. Surely the shades of Hamlet and Portia and Othello have a definite place among the objective phenomena of Earth just as surely as their names have a fixed place in our literature. Doubtless, at times this posthom of Shylock crosses the Rialto bridge, and the phantom of melancholy Jacques may be found flitting disconsolate through the forest of Arden. The sad plight of the posthom King of Denmark, for example, has not failed to touch the hearts of all lovers of literature. Indeed, the strength of the genius of Shakespeare is such that the ancient king and his famous son and namesake have as firm a reality as that of the mediocre flesh and blood people which swarm in modern society. We may notice in passing that the speech of the phantom king indicates that he was plunged in the depths of sorrow. "The impression left on the mind," says D'Assier, "by the lamentations and the vain replies of the shades who succeed in making themselves heard is always a sentiment of profound sadness." He compares the feelings of such a personage to those of a European transported suddenly and nakedly into the wilds of Australia, with just enough of his reason left "to have the feeling of his impotence and eternal isolation."

Dr. Eliphas Levi, in his famous 'Dogma and Ritual,' traces the career of shades still more closely, emphasizing especially the existence of two mortal bodies after death, the one heavy and confined on the earth, the other flitting about in the mediate atmosphere. "When a man has lived well," says Dr. Levi, the astral corpse or posthom "evaporates like a fine incense in mounting to higher regions. If the subject lived in crime this phantom retained as prisoner seeks the object of its passions and tries still to cling to life. But the stars breathe it and drink it ('les astres l'aspirent et le boivent'). It feels its intelligence grow feeble. Its memory is slowly lost; all its being must dissolve."

Those scientific men (and there are many) who find all attributes of the universe derived from the four gases, hydrogen

(blue or spirit), phosphorus (red or hope), carbon (black or fear) and nitrogen (green or life), derive from their postulates a different view of the nature of shades and phantoms. In the famous treatise on the 'Discovery of Misconceptions' this theory is set forth in an engaging manner.

"The ethnological divisions of the human race," says the author, "proceed directly from excessive vibrations of these four gases. The white skin of the Caucasian marks an approach to the harmonious relation of the four gases. This relation has been gradually produced by salt or the hidden blue hydrogen imbedded in salt. The skin and characteristics of the Ethiopian mark the superior force of carbon and phosphorus; those of the Mongolian, of sulphur, or a combination of hydrogen and phosphorus; those of the Indian, of nitrogen and hydrogen. Through the same study of the natural relation existing between the four gases, all natural forms, from a microbe to a whale or elephant, may be understood."

In such fashion the materialists have endeavored to set aside all problems of the posthom phantom, by resolving them with the hopes and fears of man into gas, controlled by colored forces of chemical relation.

On the other hand, immaterialists claim that of all forms of fluidic forces personal magnetism is the most potent. It is shown by Mr. William Q. Judge that the astral light of the imagination can form images of all imaginable things, and these, by the magnetism of the will, can be clothed in matter through precipitation. These objects will readily fade away unless fixed by some permanent mordant. "The distinct image of every line of every letter or picture," says Mr. Judge, "is formed in the mind, and then out of the air is drawn the pigment to fall within the limits laid down by the brain,'the exhaustless generator of face and form.'"

Mr. Dean found himself unwilling to differ from so high an authority as Mr. Judge, who, more than any other recent investigator, has sounded the limitless ocean of sciosophy. The facts, however, remain. To the materialist, on the one hand, he would say: "There are more things in heaven and earth than are dreamed of in our philosophy, surely far more than hydrogen, carbon, nitrogen and phosphorus." To the immaterialist he would emphasize this fact: There is not a posthom phantom extant which has not its double in material things. When the body decays the *posthom* disintegrates. When the tree falls its shadow falls with it, and there is no adequate evidence that a true shadow can be made by the precipitation of fine forms of matter on the image laid down in the brain.

A vision thus formed in the brain could surely have no digestive apparatus, yet no phantom is better attested than the donkey of St. Croix, who for several days after his actual death and burial was seen by several gentlemen wandering about in its old pasture, cropping the fluidic shadows of the growing oats. Careful observations showed that the actual oats suffered no injury. It is not likely that the donkey would feed on oats unless it retained a stomach in which oats could be placed. Whether actually digested or not would not affect the argument.

The images formed in the brain have no anatomy; and though, no doubt, actual matter is often precipitated upon them, in accordance with Mr. Judge's observations, the result is rather a picture than a posthom, as only the side of the posthom image nearest the brain is actually developed and materialized. If Mr. Kardec had given close attention to the shadow of Tartuffe he would have found it a flat bas-relief or spiritual cameo instead of a figure in perspective.

That posthoms can accomplish at times great material results is beyond question. Under the head of the "geometry of phantoms," Dr. D'Assier makes the important

observation that "invisible projectiles hurled by posthoms produce mechanical effects as great as if they were of great bulk." This he shows is due to the fact that "all bodies have their phantasmal doubles, which the shade can detatch and grasp. The garments it carries, the objects it holds in its hand, are phantasmal images borrowed from its former wardrobe or its former utensils. It is presumable that the same holds as to invisible projectiles; in lieu of stones they fling their duplicates."

It may seem surprising that the shadow of a stone could harm any one or produce any sort of a physical commotion. But here we are to remember that it is not the weight of a thrown object which tells, but its momentum. Its momentum is its weight multiplied by its velocity. "Its live force at the moment of fall," says D'Assier, "is equal to half the bulk multiplied by the square of its velocity." It is well known that the velocity of a living posthom may be scarcely less than that of a flash of light. The instantaneous apparition and disappearance of phantoms shows this. The true posthom never deliquesces, as the old-fashioned ghost is said to do, but in reality it moves away with much celerity. It is plain, then, that however light a shadow may be, it is a terrible weapon when hurled with almost infinite velocity by a disembodied posthom. Its concussion might be heard as a great shock, if flung with sufficient force. It is related that in the castle of Schreckheim, in Franconia, a posthom once entered the pantry on a shelf of which was the ancestral china of the noble house. Soon a mighty crash of breaking dishes arose. On entering the room the noble lord of the castle found everything in place. The excited posthom had merely flung down the phantasms of the different pieces of china, but with a force so mighty that the noise reverberated to the outer walls of the castle. It may be thought that the posthom in question was that of a servant girl who had been deeply reproved for breaking a favorite teacup, and who, dying soon after, had this method of expressing her vanishing feelings. But, curiously enough, the servant girl whose posthom caused the disturbance recovered from her illness and lived to break many more pieces of rare china, in this and other castles to which she was sent by the intelligence office in Nuremberg. From this we may conclude that her illness was due to the temporary breaking of the vascular plexus which holds the posthom to the body, and that when her shadow came back from its rounds her health was promptly restored.

It is, in fact, certain that very many forms of disease, known as anæmia, neurasthenia, echolalia and the like are due to the temporary absence of the posthom shadow. It can be sought for by direct means, and it will usually be found engaging in absurd and freakish actions. An effective method of cure is to strengthen the degree of personal magnetism and to bring the shadow back by a strong effort of the will. Mental healing, mind-cure suggestion, astral magnetism and the like are forms of this process. Contact with certain relics has produced an odic shock which has served the same useful purpose.

In concluding this most interesting discourse, soon to be printed in full in the annals of the Club of Alcalde, the distinguished sage of Angels asserts that we shall do well to heed the wise words of Dr. Adolphe D'Assier: "Let us not be deceived by appearances and let us be on our guard that in exploring the domain of the shades we may not take a shade of reasoning for reasoning itself." For Logic as well as Magic has also its Phantasmal Double, and when truth dips wearily under oblique suns the two are apt to range very far apart.

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SCIENTIFIC BOOKS.

A Short History of Astronomy. By Arthur Berry. New York, Charles Scribner's Sons. 1899. Pp. xxi + 440. Price, $1.50.

Astronomy is a science whose history may be said to have been over-exploited. In French there are the great works of Delambre, La Place and Bailly, Biot and Tannery; in German, those of Jahn and Wolf, Epping and Strassmayer; and in English, mainly Grant's classic work, which won him the gold medal of the Royal Astronomical Society, Sir George Lewis's Astronomy of the Ancients, and Miss Clerke's admirable, accurate and delightfully readable history of astronomy during the 19th century, not to mention other and more recent works by Sir Norman Lockyer.

Clearly there could have been no clamor for a new history when Mr. Berry, an assistant tutor at Cambridge, England, undertook his task; if demand there was, it was rather the exigency of the 'University Series.' Had its volumes been twice their present size, and had Mr. Berry taken time to familiarize himself with originals, instead of compiling 'largely from second-hand sources,' as he has to admit, his book would still have been but a 'Short History'; but he might well have achieved a contribution of permanent worth, for he is by no means deficient in aptitude for the task. However, his confessed lack of knowledge of and sympathy for the observational side of the science has induced him to erect his edifice on insufficient foundations, so that homogeneity of structure is baldly impossible.

Although the illustrations number 120, there is no picture of a telescope save one a hundred years old and more; no statement of the principle of the achromatic telescope, without which the astronomy of to-day would for the most part have been non-existent; no mention of Dollond, its acknowledged inventor, nor of the greatest builders of telescopes — Grubb, the Henry Brothers, Steinheil—not even the Clarks. Spectroscopes, the very staff of the new astronomy, are singularly neglected. With this author, compression has been insistent, but it has largely been gained by deliberate and not very well considered exclusion. His work thus produces an impression of being fragmentary rather than comprehensive.

Firstly, it seems unnecessary to have devoted an initial twenty pages to sheer elements, found in, and only appropriate to, a mere text-book of secondary grade. The most ancient astronomy is dismissed in rather summary fashion, as was necessary. Archaic and elementary mathematical conceptions are well sketched, and the frequent biographic notes afford a much needed enlivening of the text, although of slender astronomical significance.

Mr. Berry perpetuates the old-time error regarding annular eclipses, by a diagram showing an impossibly large sun centrally obscured by an impossibly small moon, still further darkened by impossible black spots on its surface (page 59). The advances of Hipparchus and Ptolemy are excellently narrated. With the life and work of Copernicus, Kepler, Galileo and Descartes is concluded the first half of the volume.

Naturally, the lives and works of Newton and the Herschels receive the fullest attention; but Mr. Berry fails to state the law of universal gravitation quite correctly, its most general form involving the product of the masses of bodies concerned, not their sum (page 228). And it would be rather difficult to defend this book against the charge of insularity, for the English astronomers are accorded vastly more consideration than the Continental, let alone Americans, who are conspicuously passed over. We have only scanty space for a catalogue of especial omissions; but may instance, among Germans, the classic work of Schmidt and Lohrmann on the moon, of Brünnow and C. A. F. Peters on stellar distances and the constants of astronomy, of Chladni upon meteors, of Kaiser upon the planets, of Heis upon meteors and stellar magnitudes, of D'Arrest and Lamont upon the nebulæ, of Oppolzer upon eclipses, of Auwers upon stellar catalogues and other departments of exact astronomy, and of Spoerer upon the sun, his remarkable 'law of spot zones' being nowhere alluded to. For France and Italy the omissions are less serious, though Gassendi, De l' Isle, Pingré, Lemonnier, Montucla, Méchain, Oriani, Pons, Foucault and Deslandres were much better included than

ignored; while among Americans we look in vain for C. H. F. Peters and Watson, Benjamin Peirce and G. P. Bond, Olmsted and H. A. Newton, Rutherfurd and the Drapers, the Clarks and Gould, and Langley's epoch-making research on the infra-red rays of the solar spectrum.

When Mr. Berry reaches the 19th century, staggered by the accumulation of material, he deliberately abandons his task by attempting a summary in a single chapter. Here he scores a signal failure, in a sketchy agglomeration of fragments, with omissions quite as prominent as inclusions. As a running précis, or evanescent periodical paper, the chapter is excellent, though proportionately out of balance with the preceding twelve chapters. Parts of Mr. Berry's book are so well done that a subsequent edition would be quite worth an expansion or sub-division of this chapter, for the sake of appropriate exposition of the 'New Astronomy,' and the instrumental means that alone have made its marvelous revelations possible. Had the whole of Mr. Berry's short history been compressed proportionately to this chapter, the book would have been but one-third its present size. Solar research, in particular, is dismissed very cavalierly.

Every one using Mr. Berry's compend for reference would appreciate a new index. A double index is a mistake. But a greater one is the baffling system of reference, wholly ignoring the pages of the book, and increasing at least fourfold the time and labor of finding any indexed allusion to a name or subject. What is printed is simply an index to the MS., not to the printed volume itself; whereby the author has saved his own time and that of his helpers, but has wasted that of everybody who attempts to use his book as a reference work. The same remark applies to frequent cross-references throughout the volume, which would otherwise have been most helpful.

Misprints are, fortunately, few, but we find preserved and dignified that widespread error of the common kind that the navigator gets his longitude from solar sights at apparent noon: were all navigators to follow this method, and no other, we wonder how many ships would escape being put ashore. Nine excellent portraits of astronomers adorn the book, from Copernicus to Sir William Herschel.

DAVID P. TODD.

AMHERST COLLEGE.

De la methode dans la psychologie des sentiments. Par F. RAUH. Paris, Felix Alcan. 1899.

This book is not what the title would suggest, a monograph on Method in the Psychology of Emotion, but a general summary and discussion of theories of emotion, particularly of recent theories, and of methods so far as involved. After some introductory definition M. Rauh takes up the physiological, intellectual, the biological or voluntarist, and the specialist theories, if we may summarize the theories by abridging his terms. His critique of the physiological, or organic, theory of the James-Lange school is quite full. He concludes: "On peut dire qu'une des caractéristiques de la physiologie physiologique a été la superstition du mouvement, en particulier du mouvement musculaire. Si au lieu de considérer les relations des faits de conscience et des mouvements périphériques, on considère celle des faits de conscience et du cerveau, nous avons vu combien cette correspondance est complexe et encore obscure. Ce qui fait croire que l'on peut expliquer scientifiquement les sentiments et en général les faits de conscience par les mouvements organiques, c'est que ces mouvements marquent en effet la limite d'action des faits psychiques." (P. 148.)

As to the intellectual interpretations of emotion, whether from the side of sensations or ideas, he regards this as of much more importance than the psycho-physiologists allow. It may be called a universal interpretation, though not an explanation. In this he follows a rather disputable distinction of theories. "Nous désignerons les théories, qui *traduisent* les faits sans permettre de les prévoir, du nom de théories *interprétatives;* nous appellerons théories *explicatives* celles qui permettent de les prévoir" (P. 27). But a mere formal or descriptive interpretation scarcely deserves the term theory. The biological principle of the struggle of existence is discussed at some length and granted some place, but not regarded as universal. He emphasizes such exceptions as

the neurasthenic and sea-sick, with whom emotion is a desire of death rather than life. But we do not think that these and other instances (*e. g.*, play, p. 281) interfere with the general theory that the origin and development of normal emotion is by its life significance. He identifies the voluntarist with the intellectualist theory. "Un organe tend à être, c'était en réalité dire: il y a une pensée dans cet organe qui le veut tel ou tel: l'être qui tend à être est toujours une pensée. Les sentiments indécomposables, irreductibles à toute explication physiologique ou intellectualiste—qui en un sens existent, comme nous l'avons pu conclure de ce qui précède, comme nous le verrons mieux dans le chapitre suivant—impliquent eux-mêmes une traduction intellectualiste." In the next chapter here alluded to he treats of emotion as special, *sui generis*, indecomposable facts of consciousness. He regards 'sentiments proprement dits' as those which are either unanalyzable or whose quality cannot be determined from their component parts. Such emotions are love, friendship, etc., but which are to be studied both from the organic and intellectual points of view. M. Rauh's general conclusion is that analysis is the indispensable preliminary in the study of emotion. This should be followed by tracing them to their organic and intellectual causes and learning the mode of causal action, or, when emotions are unanalyzable, their causal action should be traced. But in all this we must remember that psycho-physiology can only show the body as limit, but not as real cause or even always as measure of emotion. Psychology, here as elsewhere, seeks not unity, but actual practical previson.

While M. Rauh's work appears to us too cursory and discursive, covering too wide a field and reaching too vague and eclectic conclusions, yet it shows considerable thought, and ought to be suggestive to the student of Emotion.

Hiram M. Stanley.

BOOKS RECEIVED.

Talks to Teachers on Psychology; and to the Students on some of Life's Ideals. William James. New York, Henry Holt & Co. 1899. Pp. xi + 3–1.

Defective Eyesight. D. B. St. John Roosa, M.D. New York and London, The Macmillan Company. 1899. Pp. ix + 186.

Le Climat de la Belgique en 1897. A. Lancaster. Brussels, Hayez. 1898. Pp. 202.

La Specificité Cellulaire. L. Bard. Paris, G. Carré and C. Naud. 1899. Pp. 100.

La Sexualité. F. Le Dantec. Paris, G. Carré and C. Naud. 1899. Pp. ix + 98.

La Théorie de Maxwell et les oscillations Hertziennes. H. Poincaré. Paris, G. Carré and C Naud. Pp. iv + 80.

SOCIETIES AND ACADEMIES.

AMERICAN MATHEMATICAL SOCIETY.

In the month of April the American Mathematical Society held two meetings. On Saturday, April 1st, the Chicago Section of the Society held its spring meeting at Northwestern University, Evanston, Ill., and on Saturday, April 29th, the regular April meeting of the Society was held at Columbia University, New York City. At the latter meeting, guarantees of support having been received from a large number of universities, the final steps were taken for the publication of the *Transactions* of the Society. The Board of Editors appointed by the Council consists of Professors E. H. Moore, E. W. Brown and Thomas S. Fiske. The first number of the *Transactions* will appear in January, 1900. The *Bulletin* of the Society will hereafter be devoted more exclusively to the publication of critical and historical material and to very short original articles, especially such as present in concise form results of general interest or importance.

At the meeting of the Chicago Section the following papers were read:

(1) Dr. Harris Hancock: 'Primary functions.'

(2) Professor E. W. Davis: 'The group of the trigonometric functions.'

(3) Professor H. Maschke: 'On the continuation of a power series.'

(4) Dr. Kurt Laves: 'Lagrange's differential equations for a solid of variable form derived from Hamilton's principle.'

(5) Professor E. H. Moore: 'The decomposition of modular systems connected with the doubly generalized Fermat theorem (second communication).'

(6) Professor James B. Shaw: 'Some generalizations in multiple algebra and matrices.'

(7) Professor J. W. A. Young: 'On the first presentations of the fundamental principles of the calculus.'

(8) PROFESSOR A. S. HATHAWAY: 'A new method of presenting the principles of the calculus.'
(9) PROFESSOR E. H. MOORE: 'On the subgroups of abelian groups.'
(10) MR. CARL C. ENGBERG: 'A modification of the theory of the characteristics of evolutes (preliminary communication).'
(11) DR. L. E. DICKSON: 'Certain universal invariants of linear modular groups.'
(12) DR. L. E. DICKSON: 'Concerning the four known simple groups of order 25,920.'

The following is a list of papers read at the New York meeting of the Society:

(1) DR. J. I. HUTCHINSON: 'The asymptotic lines of the Kummer surface.'
(2) DR. L. E. DICKSON: 'The known finite simple groups.'
(3) MR. E. B. WILSON: 'Note on functions satisfying the equation

$$\phi(x)\,\varphi(y) = \phi(x+y).$$'

(4) DR. A. S. CHESSIN: 'On the differential equation of dynamics.'
(5) PROFESSOR CHARLOTTE ANGAS SCOTT: 'A proof of Noether's fundamental theorem.'
(6) DR. G. P. STARKWEATHER: 'Non-quaternion systems containing no skew units.'
(7) PROFESSOR E. GOURSAT: 'Sur la définition générale des fonctions analytiques d'après Cauchy.'
(8) PEOFESSOR F. MORLEY: 'The value of

$$\int_0^{\frac{\pi}{2}} (log\ 2\ cos\ \phi)^m \varphi^n d\phi.'$$

(9) PROFESSOR E. W. BROWN: 'An elementary illustration of the connection between the current and the height of the water in a tidal estuary.'
(10) DR. W. M. STRONG: 'The determination of non-quaternion systems in six units.'
(11) PROFESSOR E O. LOVETT: 'Curves of multiple curvature.'
(12) PROFESSOR JAMES PIERPONT: 'Elliptic functions.'
(13) MR C. J. KEYSER: 'On a definitive property of the covariant.'

The summer meeting of the Society will be held at the State University of Ohio, Columbus, Ohio, on Friday and Saturday, August 25th and 26th, in affiliation with the meeting of the American Association.

F. N. COLE,
Secretary.

COLUMBIA UNIVERSITY.

THE NEW YORK ACADEMY OF SCIENCES—SUB-SECTION OF ANTHROPOLOGY AND PSYCHOLOGY.

A REGULAR meeting of the sub-section was held April 24th, in association with the Anthropological Club.

The first paper was read by E. A. Gerrard, and gave methods for the study of emotional expression as found in literary compositions. The relative emotional values of the different parts of speech, of different sentence lengths, and other variations in the kind of language used and in its arrangement, were discussed and illustrated by curves derived from a number of writings.

S. I. Franz presented some results of experimental investigations of visual after-images. The latent period increases as the area of stimulation decreases, but decreases as the intensity and duration of stimulation increases. The duration of the after image increases with any increase in the intensity, duration and area of the stimulation. The after-image of the colors in the middle of the spectrum is not more intense than that of the extreme colors if the intensity of the colors is first equalized. The degree of attention is of the first importance in determining the duration of the after-image. Retinal transference is not real; its apparent reality is due to the impossibility of distinguishing the fields of vision of the two eyes.

J. R. Swanton discussed the structure of the Chinook language. Discourse in this language shows great lack of subordination, its short sentences following each other without connectives. The verbs are aggregations of many pronouns added to a short stem. They serve in this way to epitomize the whole sentence, object and indirect object, as well as subject.

Stansbury Hagar read a paper on the Astronomical Cosmogony of the Peruvians. The paper aimed to show the large amount of astronomical knowledge possessed by the Peruvians and the intimate relations between their ritual and political life and their astronomy.

CHARLES H. JUDD,
Secretary.

PHILOSOPHICAL SOCIETY OF WASHINGTON.

THE 501st meeting of the Philosophical Society of Washington was held at the Cosmos Club on April 29th. An informal communication was first made by the Secretary on Recent Geodetic Operations in Spain, special attention being given to the Base of Madridejos and to the Triangulation connecting Spain and Algiers. The results from the Base Measurement showed it to be one of extreme accuracy. The manner in which the work was carried out threw new light on the most desirable lengths of Base Lines in general, inasmuch as it was shown that greater economy with equal accuracy can be attained by measuring short lines and expanding them by careful triangulation. The geodetic connection across the Mediterranean was made the occasion to demonstrate that longitudes may be determined by means of optical signals quite as accurately as by the electric telegraph.

The first regular paper of the evening was by Mr. J. F. Hayford. The author made a statement of a new treatment of refraction in trigonometric-height computations recently used by the Coast and Geodetic Survey in connection with triangulation in Colorado, Utah and Nevada, involving lines of sight from 100 to 182 miles long. The term of the strict formula (See Wright's Adjustments, p. 387), which involves the square of the distance and the difference of the refraction coefficients at the two ends of the line, and which is usually neglected, was here retained with marked improvement in the results. It was assumed that the refraction coefficient is a linear function of the height of a station above sea level and of the air temperature at the station.

The second paper was by Dr. H. S. Pritchett, on 'An estimate of the population of the United States in 1900 derived from an empirical formula.' Dr. Pritchett first called attention to the general form of the curve defining the relation between the population and the time. The data now at hand enabled the author to write eleven conditional equations of the form

$$p = A + Bt + Ct^2 + Dt^3$$

where p represents the population (the unit being one million), t is the time counted from 1840 the epoch of the sixth census results and A B C and D are constants to be determined. The solution of the normal equations led to the following empirical formula

$$p = 17.4841 + 5.102t + 0.63t^2 + 0.030t^3.$$

Attention was called to the very close agreement between the curve and the actual population at the time of taking the census, the two largest discrepancies being in 1860 and 1870. Both these values were abnormal, partly because of the exceptional conditions then existing, the Civil War, lack of immigration, etc., and partly on account of inaccurate census results in one or both cases.

The differentiation of the formula brought out the fact that the rate of increase is continually growing less, having fallen off from 32% per decade in 1790 to 24% in 1890.

The result of the investigation was that the best value for the population of the United States in 1900, based on its growth since 1790 is 77,472,000 with a probable error of about 250,000. As a matter of curiosity the author added that if the same law holds good in the future we would have in 1990 a population of 339 billions, in the year 2500 nearly 12 trillions and at the epoch 2900 this already appalling figure will have grown to such an extent that there will, on the average, be 11,000 inhabitants to the square mile.

The third paper by Professor J. H. Gore, on 'Geodetic Work in Spitsbergen,' was not given on account of lack of time. Professor Gore, however, showed a number of interesting lantern slides illustrating his recent visit and scientific work in that country. The paper will be given at a subsequent meeting of the Society.

E. D. PRESTON,
Secretary.

DISCUSSION AND CORRESPONDENCE.

PROFESSOR JAMES ON TELEPATHY.

TO THE EDITOR OF SCIENCE: It is evident that Professor James and I have been writing at cross purposes. On the point that Lehmann has not 'established' his explanation of the Sidgwick results I am heartily at one with James, Sidgwick, Parish and Lehmann himself. But Professor James need not have awaited the return mail from Copenhagen to wrest this

admission either from Lehmann or from me. Lehmann wrote in his original paper: "Ein exacter Beweis hierfür (*i. e.*, for his explanation) kann wohl im Augenblicke nicht geführt werden." Nor, I take it, in any future Augenblick.

On the other hand, I have never regarded this point as the point at issue. Lehmann set out to examine telepathy at large. He chose the Sidgwick experiments simply as typical series, considering the authors' names a guarantee of serious intent and careful work. In his inquiry he laid hold of a condition which had never been thoroughly investigated before, and traced its effects in experiments that were both ingeniously devised and rigidly controlled; no one can neglect the unconscious whisper in future telepathic work. His paper is a model of scientific method; he has shown us how borderland questions are to be attacked, and proved that the 'ordinary channels of sense' have unexplored resources. His suggestions will be fruitful, for the next stage of advance must be an exhaustive study of the 'number habits' which Sidgwick at first rejected, but now makes the headstone of the corner. Even granting all the contentions of the critics, therefore, I should assert that Lehmann's work is brilliant, and that it has done signal service to scientific psychology. But, as I hinted before, I do not know that quasi-mathematics has contributed much to psychology in any field of research.

I conclude with a word on the logic of Professor James' objection. A theory is propounded which, from the outset, lays claim to probability and to probability only. 'Exact proof' is acknowledged to be impossible. Criticism plays upon the theory, and the author again acknowledges that his hypothesis is not proven. Professor James, apparently forgetting the first acknowledgment, affirms that the criticism has 'exploded' the theory! What is not proven is, *eo ipso*, exploded! Is Professor James, then, ready to grant that his recent book on 'Human Immortality'—something which assuredly is not yet proven—is an 'exploded document'? If the alternatives before me are scientific isolation and companionship on these logical terms I prefer the isolation.

E. B. TITCHENER.

NOTES ON PHYSICS.

THE COMPENSATION PYRHELIOMETER.

MOST of the measurements heretofore made upon radiant energy by means of the thermopile or bolometer are relative rather than absolute in character, and the necessity for a simple and accurate method for reducing the indications of such instruments to the usual thermal units has long been felt. On this account a paper by Knut Ångström (*Wied. Ann.*, No. 3, Band 67) in which he describes an instrument for measuring radiation in absolute units is of great interest. This instrument, to which he has given the name of Compensation Pyrheliometer, is apparently simple in construction, and the results obtained from it are very reliable, the maximum error, as the author states, not exceeding 2%.

The construction of the instrument is briefly as follows: Two equal, thin (.001 to .002 mm.), blackened strips of platinum are mounted in such a manner that either or both, by means of appropriate shutters, can be exposed to the radiation to be measured.

One of the two junctions of a small constantin-copper thermo couple is attached to each of the rear surfaces of the platinum strips, the circuit of thermo couple including a galvanometer. It is evident that if one of the platinum strips is exposed to radiation the equality of temperature at the junctions is destroyed and the galvanometer is deflected. A current of electricity is now made to traverse the unexposed strip, and the strength of the current is adjusted until the galvanometer returns to zero. Under these conditions the two junctions are receiving the same amount of energy per second, and the heat developed by the current in the unexposed strip is equal to that given to the exposed strip by the radiation. A knowledge of the strength of the current and of the resistance of the strip suffices to find the value of the radiation in gramme calories per square centimeter per second. Since the strips are alike in all respects and are subjected to identical conditions, no corrections are necessary.

An interesting result obtained by Ångström is the value of the mean horizontal radiation of a Hefner normal lamp, which comes out to be 13.2 gm.-cals. per square centimeter per minute

at one centimeter distance. This value seems to be very constant, and the Hefner lamp may possibly become a standard of *total* as well as of *luminous* radiation.

A. St.C. D.

NOTES ON INORGANIC CHEMISTRY.

Two papers have appeared in the *Journal of the American Chemical Society*, by Dr. F. P. Venable, on the 'Nature of Valence.' The idea of valence in chemistry has been of gradual growth and has merely been the expression of certain chemical facts. In the case of the carbon compounds and in organic chemistry in the hands of Kekulé it has proved of immense service, and without it the wonderful development of this field in the past three decades would have been impossible. Its application to inorganic chemistry has been hardly as happy, and the original conception of a fixed valence has been abandoned for that of variable valence, but even this is limited to comparatively simple compounds. As an explanation of the structure of double salts, water of crystallization, metal-ammonia bases and other complex inorganic compounds it is wholly inadequate and possibly a hindrance. While in one form or another the conception of valence has permeated and, one might almost say, dominated chemistry, little or nothing has been known regarding its nature. To be sure, in the last decade or so several hypotheses have been offered by van't Hoff, Wislicenus, Victor Meyer, Knorr, Flawitzky and a few others, attributing valence to electrical phenomena, space relations of the atom, etc., but none of these attempted explanations has received any measure of support. The hypothesis which Dr. Venable puts forth is that valence is dependent upon vibratory (or kinetic) equilibrium of the atoms. "The question as to whether the atoms of two elements will unite is decided by affinity which is in some way connected with the electrical condition of the atoms. There is no apparent connection between this and valence." But the atoms "are endowed with motion, and this motion probably varies in velocity and phases with the different elements." "A molecule, in order to exist, must maintain a certain equilibrium and harmony between these various motions, so that there can be all degrees of equilibrium from the very stable to that which may be upset by the least disturbing influence from without." Variable valence will be, in part at least, dependent upon the temperature, and a "sufficiently high temperature may prevent any harmony of motion whatever being attained, and hence union may become impossible." Valence would then be dependent upon the possible harmony of motion between the different atoms. The hypothesis is simple and satisfactorily explains many at least of the facts; thus, for instance, the zero valence of elements like argon and helium might be due, not to their possessing no chemical affinity (though this may be the case), but to their motion not being capable of harmonizing with that of any other element. The weak point of the hypothesis is the difficulty of proving it to be true. It would be necessary to first know the nature of the motion of the atom, a problem yet unsolved. It is possible that the spectroscope could aid, but at present we have no clue as to why some elements, as iron, furnish a complex spectrum, while others, like sodium, give a relatively simple one. At all events Dr. Venable's idea furnishes a good and simple working hypothesis, and one which may have its practical uses for teachers.

Attention should be called to the *First Supplement* to Dr. H. Carrington Bolton's *Select Bibliography of Chemistry*, 1492–1892, which has just been published by the Smithsonian Institution. It includes works omitted in that volume, and brings the literature of chemistry down from 1892 to the close of 1897. Dr. Bolton has been fortunate in having the cooperation of a number of scholars abroad, who have contributed more than 2,000 titles in Arabic, Finnish, Japanese, Bohemian, Dutch, Portuguese, Swedish, Danish, Norwegian and Russian, no less than 760 titles in the latter language being furnished by Professor A. Krupsky, of St. Petersburg. Dr. Bolton's bibliographical work is invaluable to chemists and is carried out in a manner which is above criticism.

Professor F. Emich, of Graz, has been kind enough to send me a paper from his laboratory by F. Dörner, with a chemical investigation of the cement from antique water conduits. The

material was collected by Dr. P. Forchheimer during an exploring tour in Asia Minor, and was from Ephesus and Smyrna. The different specimens may have been from different periods, from several centuries before Christ to three centuries after Christ, but the general composition of all was the same. The mineral matter was chiefly calcium carbonate, but from 2 to 8 per cent. of organic material was present. This proved to be merely a mixture of fatty acids, and gave evidence that the cement was the oil-cement mentioned by early writers, as Pliny and Vitruvius. A series of experiments showed that a cement of burned lime and olive or linseed oil was not permanent, but that a mixture of two-thirds air-slacked lime and one-third olive oil hardened rapidly and was very durable. It is probable that this was approximately the mixture used in the ancient cements examined.

J. L. H.

BOTANICAL NOTES.

WOOD'S HOLL BOTANY.

IT is encouraging to note the continuation of the good work in botany which has been a feature of the Marine Biological Laboratory at Wood's Holl, Mass., and to observe that from year to year it is gaining in strength, both as to kind and quality. This year, beginning on the 5th of July, work is offered in the following lines, viz. :

1. Plant Morphology and Physiology, including the Cryptogams.
2. Lectures on the Algæ, with a study of many types.
3. Plant Cytology, for advanced students.
4. Special Investigations.

The first course should be especially helpful to students and teachers, since it will afford an opportunity of meeting and hearing many of the men who are adding to our knowledge of plants in many departments of botany. It is worth much to learn something of the personality, methods of work and point of view, of such men as B. M. Davis (algæ), E. F. Smith (bacteria), D. T. MacDougal (physiology), D. H. Campbell (evolution of plants), L. M. Underwood (liverworts), H. J. Webber (fecundation in gymnosperms), G. F. Atkinson (higher fungi), D. M. Mottier (cytology), and D. P. Penhallow (paleobotany), and the teacher who does so cannot fail to carry into his class room next year an inspiration to higher and better work.

CORN PLANTS.

MR. FREDERICK LEROY SARGENT has brought out a pretty and timely little book on 'Corn Plants, their Uses and Ways of Life,' which should be widely used as a supplementary reader in the schools. Unlike many supplementary readers, this one is written by a man who 'knows what he is writing about,' and hence the reader is not shocked by grossly inaccurate statements or crude misinterpretations. It is a thoroughly commendable little book.

The following headings of some of the sections of the book will give an idea of its scope and the treatment of the subject: 'What Corn Plants are'; 'Corn Plants in the Field'; 'How Corn Plants Provide for their Offspring'; 'Wheat, the King of Cereals'; 'Barley, the Brewer's Grain'; 'Rice, the Corn of the East'; 'Maize, the Corn of the West'; etc.

The publishers (Houghton, Mifflin & Co.) have done their share in typography and binding to make this one of the most attractive books of the season.

CANADIAN BOTANY.

FROM the Curator of the Herbarium of the Geological Survey of Canada we have recently received the following papers, viz. : 'Contributions to Canadian Botany,' XI. and XII., by James M. Macoun, containing many new or hitherto unrecorded species (nearly all the new species were previously described by Professor Greene in *Pittonia*) ; 'The Cryptogamic Flora of Ottawa,' by John Macoun, including 220 species of mosses, 55 liverworts and 152 lichens; 'Notes on Some Ottawa Violets,' by James M. Macoun, devoted to the seven species of violets formerly included under the familiar *Viola cucullata* of the older mammals. These species are *Viola septentrionalis*, *V. macounii*, *V. venustula*, *V. cucullata*, *V. cuspidata*, *V. affinis*, *V. populifolia*. Admirable plates accompany the descriptions and make clearer the characteristics by which they are distinguished.

THE SOCIETY FOR THE PROMOTION OF AGRICULTURAL SCIENCE.

Nearly twenty years ago (September, 1879) half a dozen men conceived the idea of organizing a society of scientific men, the object of which should be to promote agriculture by fostering investigation in science applied to agriculture. As a result the Society for the Promotion of Agricultural Science came into existence, and its members have met once a year in connection with the American Association for Advancement of Science. Last August the Society held its nineteenth meeting, at which the President, Dr. B. D. Halsted, presented a historical summary of the work accomplished since its organization. In this time (not including the Boston meeting last year) the members presented and the Society published 278 papers. It is gratifying to the botanists to know that of this number 102 dealt with botanical problems. These were grouped as follows: Structure and physiology, 26; agrostology, 16; pathology, 43; weeds, 7; seeds, 10. The following titles taken almost at random from the list of botanical papers will show that the botanist who wishes to have copies of all important botanical publications must include those which have appeared in the Proceedings of this Society: 'Variations in Cultivated Plants,' 'Notes upon the Flowering Plants of Ohio,' 'Notes upon Bean and Pea Tubercles,' 'The Agricultural Grasses of Arizona,' 'Grasses and other Forage Plants best adapted to endure Drouth,' 'A Tomato Disease,' 'The Scab of Wheat Heads,' 'New Experiments with Fungicides for Smut of Wheat and Oats,' 'The Weedy Plants of Ohio,' 'The Vitality of Seeds Buried in the Soil,' 'Delayed Germination of Cocklebur.'

Charles E. Bessey.

The University of Nebraska.

THE FORESTS OF CANADA.

The United States Consul at Montreal, Mr. Bittinger, has sent to the Department of State a report showing the distribution of forests in Canada and throughout the world. The following table shows the area of the forests in the different Provinces:

Province.	Total area.	Woodland.	Percentage of wood.
	Sq. miles.	*Sq. miles.*	*Per cent.*
Ontario.....	219,650	102,118	46.49
Quebec.....	227,500	116,521	51.22
New Brunswick...	28,100	14,766	52 55
Nova Scotia.....	20,550	6,464	31.45
Prince Edw. Is.....	2,000	797	39.85
Manitoba.....	64,066	25,626	40
British Columbia..	382,300	285,554	74.69
N'thwest Ter.....	2,371,481	696,952	29.38
Total	3,315,647	1,248,798	37.66

The quantity of pine is estimated, in Ontario, as 19,404,000,000 board feet; in Quebec, at 15,734,000,000 feet; in the other Provinces, at 2,200,000,000 feet; total, 37,338,000,000 feet. A low calculation of the annual cut is 1,000,000,000 feet, in which case Canada has not more than forty years' supply, and the growth of new wood, in spite of all regulations, is not nearly equal to the cut. It is impossible to give anything like a just return of the spruce limits, estimates being so diverse as to be useless.

The great tree of Ontario is the white, or Weymouth pine. There are also the red pine, spruce, hemlock, etc. The valuable black walnut, tulip, plane and coffee trees are almost extinct. The quantity or value of timber can not be given, as many millions of acres are utterly unexplored. In the known woods a return to the Ontario government states that there are 60,410,000,000 feet.

Quebec, with its newly added territory, is now an even larger Province than Ontario. Vast regions to the north are unknown. The white pine is the most important tree, as in Ontario; it is, however, rapidly disappearing. Rich spruce is noted in Bonaventure River au Bouleau, Chicoutimi county, River French and Bay Lake. There is great waste of hemlock, on account of its bark.

Some of the best cedar areas of the country are on the north shore of New Brunswick. An unsurveyed area of some 2,000,000 acres on the Upper Restigouche is reported to be full of good spruce and cedar. The pine forests, at one time rich, have been greatly impoverished. The same is true of Novia Scotia. A quantity of good spruce is left in the last-named Province, but it is being used in a similar way.

British Columbia may be said to possess the largest compact timber resources in the world. Only the fringe has been cut. It is estimated that the Douglass pine, cedar, spruce, Alaska pine, etc., standing in the railway belt, amount to 25,000,000,000 feet, worth $25,000,000. The coast is heavily timbered as far north as Alaska. There is no white pine, but spruce attains perfection in this section.

The following table shows the area in forests in various countries of the world:

Country.	Acres in forests.	Percent'ge of total area.
Europe.		
Austria	24,172,360	32 58
Hungary	18,777,771	23.52
Belgium	1,243,507	17.08
Bulgaria	3,291,100	12
France	23,466,450	17.92
Germany	34,347,000	25.70
Greece	2,025,400	12.60
Italy	10,131,235	14.31
Norway	19,288,626	24.53
Portugal	1,163,841	5.25
Roumania	4,942,000	15.22
Russia	498,240,000	37.15
Servia	5,763,163	48
Spain	16,354,941	13.03
Sweden	44,480,000	40.65
Switzerland	2,259,018	20.12
Turkey	3,500,000	8.93
United Kingdom	2,695,000	4
America.		
Canada	799,230,720	37.66
United States	450,000,000	23.29
British Guiana	5,760,000	18
Asia.		
India	140,000,000	25
Turkey	17,500,000	.....
Japan	28,700,000	30.24

AN EXHIBITION OF GEOGRAPHICAL AND GEOLOGICAL MATERIAL.

THE City Library Association of Springfield, Mass., has recently erected a fine building, which is to be devoted to the display and use of collections in Natural History. As some interval of time must elapse before the collections can be installed, there has been arranged in the main museum hall — 123x47 feet in dimensions—an attractive and instructive exhibition of material which illustrates the rapid advance in geography and geology.

A study of this collection of maps and publications reveals great activity on the part of government and publishers in map-making and in the adaptation of recent discoveries for the use of school and colleges. An opportunity is offered to compare the technique and scope of the surveys and maps made by the United States, England, France and Germany. There are displayed a number of sheets of the Ordnance Survey of England and many staff maps from Germany and France. The clearness with which a multitude of details is shown on these productions is remarkable. Then the results of the topographical survey of the United States are shown in a carefully selected series of atlas sheets. The geographers of this country have taken up with much zeal the task of classifying various land forms. That such a proceeding is hedged round with difficulties is easily apparent. The best success has been had where the relative development of a region has been made the test in classification. Among the sheets on exhibition are several selected by Henry Gannett, chief geographer of the United States. Use has also been made of the recent work of Professor W. M. Davis, of Harvard University.

There is in the exhibition material which illustrates recent progress in geology. The exhibit made by the United States Geological Survey at Omaha has been loaned for the purposes of this exhibition. There are also examples of the work of the Geological Surveys of Great Britain, of Canada, of Germany and of many of the State governments. Especially fine work has been done in New Jersey under the direction of John C. Smock, and in Maryland by William Bullock Clarke. Professor B. K. Emerson, of Amherst College, has loaned his valuable manuscript maps on the geology of old Hampshire county, in Massachusetts.

There is also a very complete exhibition of the works of the best map makers in this country and abroad, and a number of relief maps. The Association cordially invites all persons interested in geography and geology to to visit the exhibition, which it is now planned to continue until July 1st.

SCIENTIFIC NOTES AND NEWS.

Dr. A. C. Lane has been appointed State Geologist of Michigan in succession to Dr. L. L. Hubbard.

Professor F. L. O. Wadsworth has resigned his position on the staff of Yerkes Observatory.

A bronze tablet, placed by the Corporation on the house in Bath in which Sir William Herschel once lived, was unveiled on April 22d. Sir William Ball made an address, in the course of which he stated that it was in the back garden of this house that the planet Uranus had been discovered and many other important astronomical observations had been made.

The death is announced of Dr. Friedrich Karl Christian Ludwig Büchner. He was born in 1824 and after practicing medicine became docent at Tübingen, from which position he was dismissed in consequence of the materialistic doctrines in his book on 'Matter and Force,' published in 1865. Thereafter he practiced medicine at Darmstadt. Büchner was well known for his series of popular works on physical science and the theory of evolution, as well as for numerous contributions to physiology, pathology and other sciences.

Professor Charles Friedel, the eminent French chemist, has died at the age of sixty-six years. Born at Strassburg, he studied chemistry in Paris under Wurtz and became a curator of mineralogy in the School of Mines and in 1884 professor of organic chemistry at the Sorbonne. He was elected member of the Paris Academy in 1878, succeeding Regnault. He made important contributions to organic chemistry and was much interested in applications of chemistry to the arts.

Mr. James Hogg, a well-known London ophthalmic surgeon and writer upon scientific topics, died in London on April 23d, aged 82 years. In addition to numerous publications on diseases of the eye he wrote many books, including 'A Manual of Photography' (1845), 'A Manual of Domestic Medicine' (1848), English Forests and Forest Trees' (1853), 'Experimental and Natural Philosophy' (1854), 'The Microscope, its History, Construction and Applications' (1854, the 15th edition 1898), 'Colour Blindness' (1863), 'Boarding-out of Pauper Children' (1870), 'Microscopic Examination of Water' (1874) and 'Arsenical Wall Paper Poisoning' (1879–89).

Professor G. C. Swallow, who has been State Geologist of Missouri and Kansas and professor in the University of Missouri, died on April 20th, at the age of 82 years.

We regret also to record the following deaths: Dr. Rijke, professor of natural history, at Leiden, at the age of 85 years; the botanist Dr. Gremley, at Egelshofen, aged 66 years; Surgeon-Major Dr. C. C. Wallich, aged 83 years; Graf Abbé Castracane at Rome; Dr. L. v. Babs, sometime professor of chemistry at the University of Freiberg, aged 80 years; Dr. M. D. Lwow, professor of chemistry in the Institute of Technology in St. Petersburg, and Mr. Joseph Wolf, the naturalist and illustrator of many important English works on natural history.

The Cambridge Anthropological Expedition under Dr. A. C. Haddon has arrived at Singapore on its way to England.

Mr. Edward H. Harriman, of New York, has invited a number of scientific men to accompany him as his guests on an expedition to Alaska. The party will leave Seattle about the end of May, on a large steamer chartered and fitted up specially for the expedition. They expect to take the 'inside passage' route to Lynn Canal, and then, after visiting Sitka, proceed westward along the coast to Yakutat Bay, Prince William Sound, Cook's Inlet and Kadiak Island. Numerous places will be visited which are out of reach of ordinary travelers, and stops will be made to admit of scientific work. Steam launches, tents, camp outfit, packers and so on have been bountifully provided, so that the largest amount of work may be done in the shortest time. Among those who have accepted Mr. Harriman's generous invitations to go on this expedition are Professor William H. Brewer, of Yale; John Burroughs, the well-known writer; F. V. Coville, Botanist of the U. S. Department of Agriculture; Dr. William H. Dall, of the Smithsonian, who has already visited Alaska 13 times; W. B. Devereaux, Mining Engineer; D. G. Elliott of the Field

Columbian Museum, Chicago; Professor B. K. Emerson, of Amherst; Professor Bernard E. Fernow, Dean of the School of Forestry, Cornell University; Dr. A. K. Fisher, Ornithologist U. S. Biological Survey; Henry Gannett, Chief Geographer U. S. Geological Survey; G. K. Gilbert, Geologist U. S. Geological Survey; Dr. George Bird Grinnell, editor *Forest and Stream;* Charles A. Keeler, Custodian of the Museum of the California Academy of Sciences; Dr. C. Hart Merriam, Chief U. S. Biological Survey; Dr. Lewis R. Morris, of New York; Robert Ridgway, Ornithologist U. S. National Museum; Professor W. E. Ritter, of the University of California, and Professor William Trelease, Director of the Missouri Botanical Garden. In addition to these men of science and their assistants, two artists accompany the expedition, the landscape artist R. Swain Gifford, of New York, and the bird artist Louis Agassiz Fuertes, of Ithaca.

MR. RUSSELL W. PORTER writes that he will conduct, during the coming summer, an expedition under the auspices of the Peary Club, the main object of which is to communicate with Lieutenant Peary. The steam-bark whaler *Hope* will leave Sydney, Cape Breton, about July 15th. She will then go directly north, through the Gulf of St. Lawrence, up the Labrador coast, through Baffin's Bay, to the west Greenland coast, stopping probably at Upernavik, and then enter Melville Bay. After passing through Melville Bay the ship enters Whale Sound, where she will cruise until communication is made with Lieutenant Peary or his Eskimo representatives. The expedition will reach Sydney on its return at the end of September. The party will be limited to six and there is at present one place vacant. While intended primarily for hunting, the expedition will afford an excellent opportunity for work in natural history. Any man of science who would like to join the party should communicate with Mr. Russell W. Porter, 6 Beacon St., Boston.

A STATE Bacteriological and Pathological Laboratory has been established for Delaware. Professor Chester, State Bacteriologist, has been appointed director.

WE learn from the *American Geologist* that the State of Wisconsin has appropriated the sum of $100,000 for two years to carry on the new geological and natural history survey of the State, of which Professor A. E. Birge, of the University of Wisconsin, is director.

THE Liverpool School of Tropical Medicine was formally opened on April 22d by Lord Lister. A visit was made to the Tropical Diseases ward in the Royal Southern Hospital and to the Thompson-Yates laboratories, and a banquet was given in the evening, at which Lord Lister made the principal speech.

DR. GEORGE BRUCE HALSTED has been invited to present a Report on Progress in Non-Euclidean Geometry at the coming Columbus meeting of the American Association for the Advancement of Science.

THE Paris Society of Biology has awarded its Godard prize for the most important contribution to biology to Dr. Vidal, of Périgueux, for his memoir on the influence of chloroform on nutrition.

THE Lenval prize for an improvement in the treatment of deafness will be awarded at the International Otological Congress that will meet in London from the 8th to the 11th of August next.

THERE will be a Civil Service examination in the State of New York on May 27th for the position of Assistant in Dietary Experiments, Lunacy Commission, at a salary of $100 per month. The duties are to assist in the experiments being conducted by Professor W. O. Atwater with a view to the establishment of scientifically correct rations and dietary for the State hospitals. The examinations will relate to the experience and training of candidates and their knowledge of and ability to conduct scientific experiments of the kind indicated.

THE French Chamber of Deputies has appointed a committee to take into consideration the application of the decimal system to the measurement of time. The Society of Geography at Toulouse began to agitate the question in 1893 and has been especially active in the matter. It may be remembered that the Convention which adopted the decimal system applied it to time and it was actually used by the French government in the year 1794.

THE more important departments of the Russian government have approved the reform of the Russian calendar urged by the St. Petersburg Astronomical Society, and will adopt at an early date the system followed by the rest of the civilized world.

THE International Bureau of Weights and Measures has been holding its sessions at Paris. Among the foreign delegates in attendance were Professors Michelson, from the United States; Cheney, from Great Britain; Tahlen, from Sweden; Blazema, from Italy; Hirsch, from Switzerland; Hepiter, from Austria; Foerster, from Germany, and Mendeljev, from Russia.

THE American Society of Mechanical Engineers is holding its spring meeting at Washington as we go to press. Rear-Admiral George W. Melville presides, and about 600 members have signified their intention of being present.

THE American Climatological Association holds its sixteenth annual meeting at the building of the Academy of Medicine, New York City, on May 9th, 10th and 11th.

THE American Library Association is meeting during the present week at Atlanta, Ga.

EXPERIMENTS were made recently at the South Foreland to demonstrate the possibilities of communicating between a moving ship and the land. According to the London *Times*, Signor Marconi joined the French commission on board the despatch vessel *Ibis*. The receiving and transmitting instruments on board the *Ibis* were in a cabin, the wire to take the current being connected with the instrument room from the top of the mast, about 150 feet high. The messages were transmitted to the *Ibis* from the South Foreland, from Wimereux, and from the East Goodwin lightship, as also from the gunboat to each of these points, and in each instance they were recorded with unerring distinctness, the French commissioners expressing the greatest satisfaction with the system. Hitherto one of the chief objections raised to wireless telegraphy has been that it is impossible to concentrate the current—in other words, to 'cut out' and prevent the message from being received at other stations where installations exist within an equal radius other than the one for which it was originally intended. Signor Marconi has now discovered an ingenious but simple arrangement by which this difficulty can be overcome, and it was tested before the French commission and at the South Foreland. Messages were first sent from the *Ibis* to the South Foreland, and, as Professor Fleming pointed out on his recent visit, were received simultaneously by the Goodwin lightship. Signor Marconi's new invention was then tried, and the messages sent to the Foreland were concentrated there and received at no other point, the lightship being cut out. A similar experiment was made with the lightship, the ships communicating with each other, while the Foreland was cut out. As a further test of this important invention messages were sent simultaneously from Boulogne and the lightship to the South Foreland, where only the Boulogne message was taken by the receiver, the other being cut out at will. This experiment was also tried on board the *Ibis* and from the other points, in each instance with complete success.

REUTER'S Agency states that Dr. Sven Hedin will start from Stockholm at the end of June on a new expedition to Central Asia, and will travel direct through Russia and Turkestan to Kashgar, taking a new route over the mountains. Dr. Sven Hedin will conduct the expedition alone, being accompanied only by his old Asiatic servant, Islam Bai, from Osh. He has received permission from the Czar to take two Cossacks as escort. On reaching Kashgar Dr. Sven Hedin will proceed in an easterly direction for the purpose of making fresh investigations in Chinese Turkestan, where he hopes to find further antiquities. Thence he will visit the unexplored Lob Region, and will cross the great Sand Desert by more than one route. After going to Tibet and exploring that portion of the country to the south of his former route, he will return *via* India. As in the case of his famous journey across Asia, Dr. Sven Hedin's objects on this expedition are purely scientific. The difficulties to be expected are of much the same character as those experienced during his former trip. Dr. Hedin is, however, better prepared than he was on that occasion, and hopes to achieve even better results than he did then. The expenses of the expedition, which

will amount to £2,000, have been defrayed by King Oscar, Mr. Emanuel Nobel and others.

THE Brussels Geographical Society has received the first report of Lieutenant Gerlache, commander of the Belgian Antarctic expedition. According to the London *Times* the report says that the expedition left St. John's Bay on January 14, 1898, and on the 21st explored the South Shetland Islands. On January 15th, in 55° 5′ south latitude and 65° 19′ west longitude, soundings to the the depth of 4,040 mètres were taken. The *Belgica* left on the 23d for Hughes Bay, discovering a strait separating the lands of the east from an unknown archipelago. The land to the east was named Danco Land. Magnetic observations were made and interesting botanical, geological and photographic results were obtained. On February 13th the *Belgica* went in the direction of Alexander I. Land, exploring the belt of bank ice towards the west. On March 10th the ship became fast in the ice in latitude 71° 34′, longitude 89° 10′. The sun disappeared on May 17th, and there was continual night until July 21st. M. Danco died on June 5th, and his remains were deposited in a tomb of ice. The *Belgica*, after leaving her winter quarters, again became fast in the ice in 103° west longitude. She reached open water on March 14th. The expedition made successful magnetic and meteorological observations and obtained collections of pelagic and deep-sea fauna and samples of submarine sediments. On February 26th Black Island was explored, and on the following day the *Belgica* entered the Cockburn Channel, arriving at Punta Arenas, in Patagonia, on the 28th of last month.

THE ranchmen of Seward County, Kansas, says the *Electrical World*, have connected their ranches by telephone facilities, using the barb-wire fences instead of setting poles and stringing wires. It had been demonstrated that a fence wire worked perfectly for a telephone connection. The scheme was favored by the stockmen, and a local company was formed, with headquarters at Liberal, that being the nearest telegraph point. Lines have been conconstructed and are in operation, extending from Liberal over the whole of Seward, Stevens and Morton Counties, Kansas, and have reached out into Beaver County, Oklahoma, and Hansford County, Texas. Many of the ranches in in this grazing country are situated miles from railroad and telegraph facilities.

THE first stone of the oceanographic museum at Monaco was laid on April 26th by the Bishop in the presence of Prince Albert, Princess Alice and the Crown Prince. Count Münster, on behalf of the Emperor William, spoke of the museum as a pledge of peace and amity among peoples, while Admiral Brown de Colstoun, on behalf of France, congratulated the Prince on his maritime researches. The Prince expressed his thanks to the German Emperor and President Loubet for sending representatives to the ceremony. As we stated recently, the museum has been founded by the Prince of Monaco for the exhibition and study of the collections made under his auspices.

A TELEGRAM has been received at the Harvard College Observatory from Professor J. E. Keeler at Lick Observatory, stating that comet Tempel was observed by Perrine, May 6, 9077 Greenwich mean time in R. A., $18^h\ 52^m\ 57^s.8$ and December 4° 32′ 19″, Faint. This is an observation of comet Tempel, 1873 II., and not 1866 I., which is connected with the meteoric swarm of November 13th. An ephemeris was published by Schulhof in Astron. Nach., Vol. 149, p. 23, which agrees within a few seconds of the position given above.

UNIVERSITY AND EDUCATIONAL NEWS.

THE great State Universities of the Central and Western States are continually growing in wealth and influence. During the present year the following additional endowments are reported: An appropriation bill recently passed by the Illinois Legislature gives to the University of Illinois about $600,000. The Wisconsin Legislature has appropriated for the University of Wisconsin $151,000, of which $100,000 is for an engineering building. The Colorado Legislature, besides passing a bill giving its State University an income of one-fifth of a mill on each dollar of assessed valuation, has made appropriations amounting to about $110,000. In Nebraska the State University has been

given a one-mill tax, which will, it is estimated, yield about $168,000 yearly.

At a meeting of the Board of Trustees of Columbia University on May 1st President Low announced that he would reimburse the University for the interest paid on money borrowed to complete the library. This will be about $75,000, making his total gift for the building $1,200,000. The offer of the Chamber of Commerce to give $15,000 a year for a course in commerce was accepted.

Columbia University has recently received a gift of $10,000, to be known as the Dyckman Fund for the Encouragement of Biological Research, the interest of which will be granted to post-graduate students. The fund is established by Mr. Isaac M. Dyckman in memory of his two uncles, Jacob and James Dyckman, of the classes of '10 and '11. The former of these, although dying when scarcely over thirty years of age, was a Fellow and Trustee of the College of Physicians and Surgeons, Health Commissioner of New York, and author of several works on medical and biological subjects. A second gift to the department of zoology is the continuance of the John D. Jones Scholarship, which was created by the Wawepex Society and includes a workplace in the Cold Spring Harbor Biological Station. A third gift is the collection of shells of Henry D. van Nostrand, which comes to the University through the generosity of his widow. This collection is well known among malacologists. It is particularly rich in pulmonates.

In order that the scientific museum of Princeton University may have a complete collection of the quails of this country, Mr. W. E. D. Scott, curator of the museum, has sent out 800 circulars to members of the alumni, asking for a pair of quail from each locality. From the many favorable replies received it is probable that the entire number desired will be secured by the fall, making a collection especially valuable for studying the geographical variation of the bird. Excellent progress is being made in mounting representatives of the South American birds received from the Patagonian expedition. The entire expense of this collection is borne by John W. Garrett, of the class of 1895.

The current issue of *Nature* gives an illustration of the proposed new buildings for the Royal College of Science, South Kensington. The British government has followed the advice of men of science and has decided to place the building on the west side of Exhibition Road, originally secured for that purpose from the Exhibition Commissioners of 1851.

The state of affairs in the Russian universities is not improving, and practically all the institutions for higher education in the Empire have been closed until the end of the present academic year. The expelled students have been scattered all over Russia, by which means it may be supposed the police are doing the most in their power to spread discontent and possible revolution.

The following table sent us from the University of Michigan shows the ratio of the teaching force to the number of students in ten of the largest universities of the country. The first column gives the number of persons composing the faculty, including instructors of all grades; the second gives the total number of students enrolled in the institution; the third the proportion of students to teachers.

	Faculty.	Students.	Ratio
Johns Hopkins	123	641	5.2
Cornell	328	2038	6.2
Columbia	303	2185	7.2
California	286	2391	8.3
Northwestern	222	2019	9.1
Harvard	411	3901	9.4
Yale	255	2500	9.7
Chicago	212	2307	10.9
Pennsylvania	258	2834	10.9
Michigan	222	3192	14.4
Total	2620	24008	9.1

Dr. Franz Boas, lecturer on physical anthropology in Columbia University, has been elected professor of anthropology in the same University. Dr. J. H. Canfield, President of the Ohio State University, has been elected librarian.

Dr. Max Wien, of the University of Würzburg, has been appointed associate professor of physics in the Institute of Technology at Aix. Professor Schrepfer, of Cologne, has been appointed professor of mechanical and electrical engineering in the University of Würzburg.